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Edited under the Authority of the Council.

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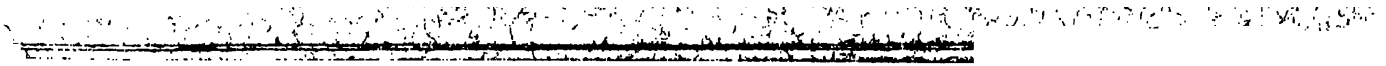

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PROCEEDINGS.

ART. I.—*On the Anatomy of an Arenaceous Polyzoon.*

By ARTHUR DENDY, M. Sc., F.L.S.

Demonstrator and Assistant Lecturer in Biology in the University of Melbourne.

[Read May 10, 1888.]

During the last Easter vacation I was enabled, through the kindness and hospitality of Mr. J. Bracebridge Wilson, to accompany him on several occasions while engaged in dredging operations at various localities near Port Phillip Heads. On one of these occasions we obtained a considerable quantity of a very remarkable arenaceous organism attached to the base of a mass of Ascidians. On my return to the University I examined my spirit-preserved specimens of this organism with some care, but without being able to elucidate its true nature. As it promised to prove of unusual interest I wrote to Mr. Wilson, asking him if he could send me some more specimens in a living condition. In consequence of my request Mr. Wilson devoted a considerable amount of time and trouble to again searching for the organism in question, and succeeded in a few days' time in sending me living specimens, not only of the species which I had previously obtained, but also of another quite distinct species of the same genus. These specimens reached me in excellent condition, and a glance at the living animal at once proved it to be a Polyzoon of very novel and peculiar form.

The genus, which is new to science, would appear to be not uncommon in Port Phillip, for Mr. Wilson informs me that he has been familiar with it for many years, and has often dredged it by the handful. He has also kindly suggested that, considering the difficulty experienced in determining its true character, the generic name *Cryptozoon* would not be inappropriate, a suggestion of which I am very happy to be able to avail myself.

I propose to call the species with which I first became acquainted *Cryptozoon wilsoni*, in honour of the well-known discoverer of this and many other new and remarkable

marine forms. The second species may be called *Cryptozoon concretum*, from the manner in which the sandy "nodes" have grown close together, with corresponding shortening of the chitinous internodes.

The new genus may be briefly diagnosed as follows:—"Ctenostomatous Polyzoa, with tubular, chitinous zoœcia enveloped in common aggregations of sand. Polypides provided with a muscular gizzard containing two horny teeth."

Before proceeding to describe the distinctive characters of the two species I will give a general account of the anatomy of the genus, so far as I have been able to work it out in such an unfavourable subject for investigation.

The chief difficulties in the way of a study of the soft tissues in *Cryptozoon*, consist (1) in the very minute size of the individual polypides; and (2) in the difficulty experienced in separating them from the mass of sand grains in which they are enveloped, and to which the zoœcia firmly adhere.

In the living animal I was able only to study the anatomy of so much as is protruded beyond the margin of the sandy mass when the animal is in a state of expansion (Fig. 1), that is to say, only the tentacles and a very small portion of the body, including the mouth and anus, together with the soft retractile portion of the zoœcium. Moreover, owing to the impossibility of separating the polypide in a living condition from the sandy mass, I could only examine it with a low power of the microscope.

Somewhat curious and more or less satisfactory results were obtained by teasing up with needles the masses of sand containing living polypides on a slide in a drop of sea water, then staining with carmine or magenta, and replacing the sea water by glycerine. After this process, there remains on the slide a quantity of more or less isolated sand grains, with here and there scattered about amongst them a polypide which has been forcibly torn from its zoœcium.

The most interesting point about this method is that the polypides are killed in an expanded condition, *i.e.*, with the lophophore expanded and the tentacles spread out at length, and separate from one another, instead of being all curved in and massed together in a compact bunch, as is the case in spirit-preserved specimens. Sometimes the lophophore, with the tentacles, is torn off from the remainder

of the polypide and can be examined from the surface, when it presents the appearance shown in Fig. 6.

The greater part of my observations were, however, made upon spirit-preserved material. Small portions of the zoarium, comprising several of the sandy masses, were stained *in toto* in borax carmine, according to the usual method. After dehydrating and clearing, the material was transferred to a slide and teased up with needles in a drop of balsam. The teased preparation was examined with a low power of the microscope, and it was possible with care to pick out the individual separated polypides on the point of a fine needle and mount them by themselves on fresh slides.

When a separate polypide was thus mounted it was possible, by carefully pushing the cover-glass with a needle, to roll it over into various positions, as might be required.

The Cœnœcium.

The Cœnœcium is dichotomously branched, and the branches come off in several planes (Figs. 2, 3, 4.) It consists primarily of a slender chitinous tube. At fairly regular intervals, usually at each angle of the branching system, this tube breaks up suddenly into a number of very delicate tubular zoœcia, which are invested in a common sandy mass.

Thus the whole cœnœcium is divisible into what may be termed, for the sake of convenience, *nodes* and *internodes*. The nodes are dense aggregations of grains of sand, enveloping and firmly held together by the chitinous zoœcia (Figs. 1, 2, 3, 4, 5, N.) The internodes are longer or shorter, slender chitinous tubes, connecting the nodes together.

I have already mentioned that the cœnœcium, as a whole, is dichotomously branched. This results from the fact that whereas only a single tubular internode enters the lower surface of each arenaceous node, there are usually two such tubes originating from its upper surface. The branching, however, is not always a perfectly regular dichotomy; sometimes more than two internodes come out from the upper surface of a node. Thus in *Cryptozoon concretum* I have observed in one instance no less than six short tubes coming out from the surface of a terminal node, in addition to the internode on which it was supported. As the node

from which these six tubes originated was the terminal node of a branch, and probably had not as yet reached its full development, it is impossible to say how many of the six young tubes would have developed into perfect branches. Each one of them was short and had a rounded apex.

It is especially worthy of note that the tubular internodes are not continuous through the substance of the sandy nodes, but each one breaks up on entering the sandy mass into a kind of *rete mirabile*, formed chiefly of the delicate tubular zoœcia.

In *Cryptozoon wilsoni*, the type of the genus, the chitinous internodes are comparatively long, and the sandy nodes are well separated from one another. In *C. concretum*, however, the internodes are very much shortened, and the sandy nodes are brought close together, and in the older parts may even be confluent, forming a continuous sandy mass (cf. Figs. 2, 3 and 4).

The zoœcia are very delicate and adhere firmly to the sand grains, so that it is impossible to separate them. Perhaps in *Cryptozoon*, as in those horny sponges which take on an arenaceous habit, the chitinous portion of the skeleton is actually reduced in consequence of the addition of the sand, which may be considered as supplementing, and possibly, to a certain extent, replacing the chitin.

However this may be, it is very difficult to obtain an idea of the true shape and arrangement of the zoœcia. I can only say that they are tubular, and appear to spring one from another in an irregular manner (Fig. 11). The mouth of the zoœcium, as in all the Ctenostomata, remains soft and unchitinised, and, when the polypide is retracted, is pulled into the hinder part by a special series of muscular bands (Fig. 11, *m.*)

The points where the zoœcia arise from one another are marked by oval scar-like areas—the rosette plates (Fig. 11, *r.p.*)

The structure of the internodes of the cœnœcium may best be studied in *Cryptozoon wilsoni*. In that species they are short, somewhat dumb-bell-shaped tubes (Fig. 5 *Inn.*), with swollen extremities, breaking up suddenly on reaching the sandy node at either end into small, irregular branches, or giving rise directly to the zoœcia (Fig. 5). The wall of each internode appears in optical longitudinal section (Fig. 10), to be clothed internally with a deeply staining epithelium (*ep.*) I have not succeeded in demonstrating

with any degree of certainty the existence of nuclei in this layer, but there can be no doubt that it is composed of cells which secrete the chitinous wall of the tube. Very often this chitinous wall is roughened on its inner surface by minute, sharp prominences and ridges (Fig. 10, *p.*), which mark the points where secretion is most actively taking place. There can be no doubt that the epithelium lining the internodes is a direct continuation of the cœlomic epithelium of the polypides, and it appears to be the only organic connection between the different polypides of the colony.

The Polypide.

The structure of the Polypide is essentially the same in both species. As much of it as can be made out in the living animal is represented in Fig. 1, while a more extensive view, such as is represented in Fig. 12, can only be obtained by teasing out the polypides in the manner already described.

The lophophore (Fig. 6) is of course circular. From its margin spring from 10 or 12 *(in C. wilsoni)* to 14 *(in C. concretum)* tentacles. Within the circle of tentacles are the mouth *(o)*, placed somewhat excentrically, and the nerve-ganglion *(n.g.)*, lying to one side of the mouth. The anus is outside the circle of tentacles, and is so placed that it lies in a line with the mouth and nerve-ganglion (Fig. 12).

The tentacles are hollow cylinders closed at their distal extremities. The wall of the cylinder, as already pointed out by Allman in the case of the fresh-water Polyzoa, is composed of two layers—an inner, apparently structureless layer (Fig. 7, *s. l.*), and an outer, epithelial layer. The epithelium does not present the same character all over the surface of the tentacle. Over the greater part of the surface it is composed of the ordinary, somewhat flattened, nucleated cells (Fig. 7, *ep.*), but on the in-turned face of each tentacle there are two parallel longitudinal rows of small columnar cells (Fig. 7, *c. c.*), each containing a relatively large, deeply-staining nucleus.

When the tentacles are examined in the living condition each one is seen to possess two rows of vibratile cilia, projecting on each side beyond its margin. Each cilium is nearly as long as the tentacle is thick, and they always move in a perfectly definite and regular manner, although detachments of them are capable of temporarily ceasing

their movement, while the remainder go on. If we imagine the inner face of the tentacle to be anterior and the outer posterior, the cilia are seen always to move upwards on the right hand side and downwards on the left.

Although I have not succeeded in observing the cilia in my mounted preparations, yet we may with safety conclude that they are definitely related to the two longitudinal rows of columnar cells just described, and that each of these cells bears a single cilium as represented in Fig. 7.

The alimentary canal is very complex, and we can distinguish no less than five perfectly distinct regions, viz., *pharynx, œsophagus, gizzard, stomach,* and *intestine.*

The mouth, as already observed, is excentrically placed within the circle of tentacles (Fig. 6, *o.*) It leads directly into a dilated pharynx lined by columnar cells (Fig. 12, *ph.*) The inner surface of the pharynx, *i.e.*, that turned towards the stomach, is more strongly curved than the outer surface, and the constriction at the lower end of the pharynx, which separates it from the œsophagus, is formed chiefly by a deep inward fold of the inner surface. A sharp re-entrant angle is thus formed, and over this angle the columnar epithelium is higher than elsewhere.

The œsophagus (Fig. 12, *œ.*) is a simple, thin-walled, saccular organ, interposed between the pharynx and the gizzard.

The gizzard (Fig. 12, *giz.*) is certainly the most remarkable portion of the whole alimentary canal. It is globular in shape and has thick muscular walls, consisting mainly of a stout circular band of muscles (Fig. 8, *c. m. b.*; Fig. 12, *c. m. b.*), oval in section and composed of a great number of delicate fibres, surrounding two relatively large chitinous teeth (*t.*) The teeth are squarish in shape, and flattened. They are planted within the muscular mass in such a manner that their broad surfaces lie parallel with the plane of the loop of the alimentary canal. This arrangement will be best understood by reference to Figs. 8 and 12.

The gizzard opens directly into the side of a very large, elongated, saccular stomach, of the shape shown in Figs. 9 and 12. The stomach is differentiated by the character of its lining membrane into two totally distinct regions—an upper, non-digestive, and a lower, digestive portion. The upper portion, next to the intestine, is lined, like the pharynx, by columnar epithelium, and the cells of this epithelium are ciliated (Fig. 9, *c. e., cil.*) At about the upper level of the

opening of the gizzard the walls of the stomach thicken, and the single layer of columnar cells gives place to several layers of spherical cells (Fig. 9, *s. c.*), containing yellow granules. As was the case in the pharynx the walls of the digestive part of the stomach are thicker in certain places than elsewhere, as shown in the figures.

In *Cryptozoon concretum* (Fig. 9) the difference between the digestive and non-digestive portions of the stomach is more strongly marked than in *C. wilsoni*, and it is in the former species alone that I have succeeded in detecting the cilia at the upper end, although there is no reason to doubt that they occur also in the latter. It should be noted, that these cilia are also figured by Allman in certain fresh-water forms.

A rather narrow aperture (Fig. 9, *o. i.*) places the upper end of the stomach in direct communication with a saccular, very thin-walled intestine (Fig. 12, *int.*), terminating at the anal opening (*a.*), the position of which, outside the circle of tentacles, has already been indicated.

The entire alimentary canal, which in all Polyzoa has the form of a loop, is clothed externally by a delicate, closely-fitting, flattened epithelium—the cœlomic epithelium (Fig. 9, *ep.*; Fig. 12, *n. e.*), the nuclei of which are plainly discernible over the greater part of its surface. On the intestine, these nuclei are in places elongated in the transverse direction, and this takes place especially in the region just opposite to the nerve ganglion, giving rise to a deceptive appearance of columnar epithelium in this locality.

To the lower portion of the stomach is attached the funiculus or posterior mesentery (Figs. 11 and 12, *fun.*) in a perfectly normal manner.

The muscular system is well developed. There are:—(1) A circle of short retractor muscles (Fig. 11, *m.*) attached above to the introversible portion of the zoœcium. Of these muscles, each of which is composed of a band of simple fibres, I have counted four, and they appear to be all attached at the same level. It is possible that a fifth occurs, but has escaped notice owing to its being hidden behind the others; (2) A broad band of long fibres (Fig. 11, *r. m.*; Fig. 12, *m.*) attached above in a semi-circle just beneath the bases of the tentacles, around the margin of the lophophore remote from the anus. These fibres converge below to a point (Fig. 11, *a. m.*) deep down on the near side o the wall of the zoœcium. This band is the great retractor muscle of

the polypide, by means of which it can be withdrawn right inside the zoœcium, as in Fig. 11. Each of the long muscle fibres (Fig. 12, *m. f.*) appears to consist of a single cell, and at a point about the middle of each there is an oval swelling; here the fibre stains more deeply than elsewhere, and this spot must doubtless be regarded as the position of the nucleus (Fig. 12, *n. m. f.*)

All that I have been able to observe concerning the nervous system of Cryptozoon is the presence of an oval ganglion, situated in the usual position between mouth and anus.

So far as I am aware, Cryptozoon is the only Polyzoon which makes use of sand in the formation of its skeleton, and it is interesting to find a Polyzoon acquiring a habit with which we are already familiar in other groups, such for example, as Foraminifera, Sponges, and Annelids. The genus is obviously closely allied to *Bowerbankia,* as is shown by the presence of the gizzard, and the aberrant structure of its cœnœcium may perhaps be best understood by comparison with that genus. In *Bowerbankia pustulosa,* for example, the cœnœcium is entirely chitinous. It branches dichotomously, and at each angle of the ramification there is a close-packed group of tubular zoœcia. We have only to imagine these zoœcia to become more irregularly and diffusely arranged and invested in a common sandy matrix, beyond the surface of which the tentacles are protruded, and we shall arrive at the condition of *Cryptozoon.* Cryptozoon, therefore, may be regarded as a *Bowerbankia,* which, for the sake of additional protection, has acquired the habit of agglomerating particles of sand on to the zoœcia.

It might perhaps even be doubted whether there exist sufficient differences to separate *Cryptozoon* from *Bowerbankia,* but the fact that there are at least two totally distinct species which form arenaceous nodes seems to me to render desirable the erection of a new genus.

I will now briefly enumerate the distinctive characters of the two species.

Cryptozoon wilsoni.

The zoarium (Figs. 2, 3) forms dense, bushy masses attached to foreign objects. Sometimes it appears to be provided with a common basal agglomeration of sand

particles, but sometimes it springs direct from the substratum on which it grows.

It is, as a rule, dichotomously branched, and the branches come off in many planes. The ramification is very profuse, which gives to the whole colony a reticulate appearance, but I have not succeeded in detecting any actual anastomoses.

The fully grown sandy nodes are spherical, and usually about 1 mm. in diameter. They are perfectly distinct from one another, and the internodes are well developed, being a little shorter than the diameter of the nodes. The terminal, young nodes are much smaller than the older, fully grown ones.

The polypides have up to 12 tentacles, although sometimes it is possible to count only 10 or 11. In the living animal the fully expanded tentacles are about 0·2 mm. long.

In one slight varietal form (Fig. 3) the nodes are somewhat larger and nearer together than in the typical form. It is this slight variety which I was able to examine in the living condition, and from which the anatomical figures are drawn.

Cryptozoon concretum.

The zoarium (Fig. 4) forms dichotomously branched tree-like masses, provided with a common sandy base. The entire growth is very much coarser than in *C. wilsoni*, and the branching, which takes place in several planes, is less copious and intricate. Sometimes, but only rarely, the branches appear to form anastomoses.

The internodes are reduced almost to nothing, and the nodes usually touch one another, or are actually fused together. It is only in the upper, younger portions of the colony that separate spherical nodes can be distinguished. In the lower, basal portions, they fuse together into common, stem-like, sandy masses. The diameter of a stem, near the base of a colony and above the basal expansion, is about 2 mm.; while the nodes which are in process of fusion and still separate gradually decrease in diameter as they approach the ends of the branches. The polypides are larger than in *C. wilsoni*, their tentacles being 0·3 mm. long in the fully expanded, living animal. The number of the tentacles is 14. The differentiation of the stomach, into digestive and non-digestive regions, is somewhat more strongly marked than in *C. wilsoni*.

DESCRIPTION OF PLATES.

PLATE I.

Fig. 1. A node of *Cryptozoon wilsoni*, with the polypides alive and their tentacles protruding from between the grains of sand. Owing to the manner in which the node is viewed the polypides are visible only around the margin, though, of course, occurring all over the surface. (*pop.*) Projecting portion of polypide. (*s.g.*) Sand grains. (*Inn.*) Chitinous, tubular internodes.

Fig. 2. Portion of cœnœcium of *Cryptozoon wilsoni*, more typical form. x 10. (*N.*) Nodes. (*Inn.*) Internodes.

Fig. 3. Portion of cœnœcium of *Cryptozoon wilsoni*, larger variety. x 4. (*N.*) Nodes. (*Inn.*) Internodes.

Fig. 4. Cœnœcium of *Cryptozoon concretum*. x 4. (*B.e.*) Basal expansion. (*N.*) Nodes. (*Inn.*) Internodes, in this case almost entirely suppressed.

PLATE II.

Fig. 5. A tubular internode of *Cryptozoon wilsoni*, separated by teasing, with a number of sand grains, held together by the chitinous branches and the zoœcia, still adherent at either end. (*Inn.*) Internodes. (*s.g.*) Sand grains. (*ch.*) Remains of chitinous branches and zoœcia, cementing the sand grains together.

Fig. 6. Lophophore of *Cryptozoon concretum* seen from above; from a specimen teased up alive. (*o.*) Mouth. (*n.g.*) Nerve ganglion. (*ten.*) Tentacles (bases only represented).

Fig. 7. Diagrammatic longitudinal section of a portion of a tentacle of *Cryptozoon*, passing through one of the longitudinal rows of columnar ciliated cells. (*can.*) Central canal. (*s. l.*) Inner structureless lamella. (*ep.*) Ordinary epithelium. (*c. c.*) Columnar cells. (*ci.*) Cilia.

Fig. 8. Diagrammatic section through the gizzard of *Cryptozoon*, showing the chitinous teeth implanted in the muscular mass. The section is supposed to pass through the two openings of the gizzard, and at right angles to the plane of the paper in Figs. 11 and 12. (*c. m. b.*) Sections of circular muscle band. (*t.*) Sections of chitinous teeth.

Fig. 9. Optical longitudinal section through the stomach of *Cryptozoon concretum*, passing through its two

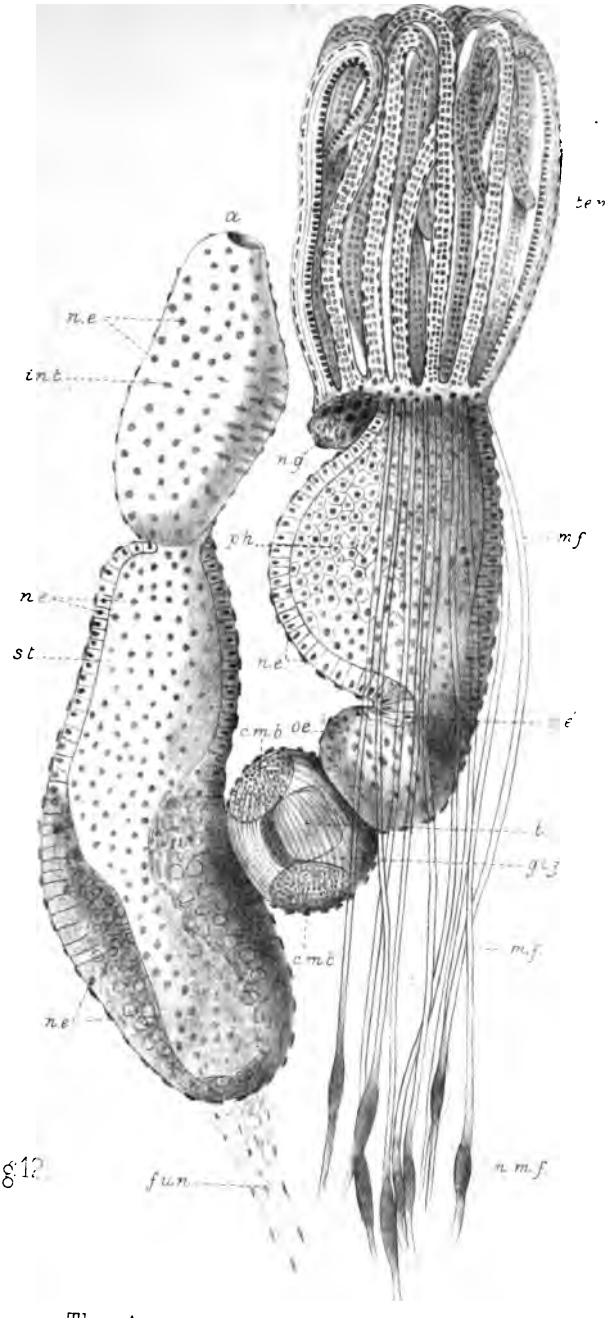

Fig 12

The Anatomy of Cryptozoon.

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openings, and showing the differentiation into non-digestive region above and digestive region below. (*o. g.*) Opening from gizzard. (*o. i.*) Opening into intestine. (*ep.*) The cœlomic epithelium, which invests the entire alimentary canal. (*c. e.*) Columnar epithelium of the upper, non-digestive portion of the stomach. (*cil.*) Cilia of the columnar, nucleated cells. (*s. c.*) Spherical cells containing yellow granules, forming the wall of the lower, digestive portion of the stomach.

Fig. 10. Optical longitudinal section through the wall of an internode of *Cryptozoon wilsoni*. (*chi.*) Chitinous wall, raised here and there into angular prominences—(*p.*). (*e.p.*) Deeply staining epithelium clothing the inner surface of the tube.

Fig. 11. A tubular zoœcium of *Cryptozoon wilsoni*, containing a retracted polypide. The zoœcium has been separated by teasing, but portions of other zoœcia are still adherent on the right-hand side, and two sand grains are still attached near the mouth of the zoœcium. (*s. g.*) Sand grains. (*w. z.*) Wall of zoœcium. (*inv.*) Invaginated portion of zoœcial wall. (*mo.*) Mouth of zoœcium. (*m.*) Retractor muscles of invaginated portion of wall of zoœcium. (*r. m.*) Retractor muscle of polypide. (*a. m.*) Attachment of retractor muscle to wall of zoœcium. (*r. p.*) Rosette plates, indicating where other zoœcia have been attached. (*ph.*) Pharynx. (*œ.*) Œsophagus. (*giz.*) Gizzard. (*st.*) Stomach. (*int.*) Intestine. (*b. b.*) Brown body (?). (*fun.*) Funiculus. (*n. g.*) Nerve ganglion.

PLATE III.

Fig. 12. A polypide of *Cryptozoon wilsoni* separated from the zoœcium by teasing, and seen from the side as a transparent object. (*ten.*) Tentacles. (*ph.*) Pharynx. (*œ.*) Œsophagus. (*giz.*) Gizzard. (*st.*) Stomach. (*int.*) Intestine. (*fun.*) Funiculus. (*a.*) Anus, represented open for the sake of clearness, though normally closed. (*n. g.*) Nerve ganglion. (*m. f.*) Fibres of retractor muscle. (*n. m. f.*) Nuclei of muscle fibres. (*t.*) Horny tooth of gizzard. (*c. m. b.*) Circular muscle of gizzard seen in section. (*n. e.*) Nuclei of the cœlomic epithelium investing the alimentary canal.

ART. II.—*The Maintenance of Energy.*

By ROBT. ABBOTT, ESQ., LICENSED SURVEYOR.

[Read April 12, 1888.]

In course of a conversation with Mr. J. P. Thomson over twelve months ago, I mentioned to him that I held different views respecting the nature and causes of volcanic action, and of elevation and subsidence, to those usually accepted. Mr. Thomson was then good enough to ask me to contribute a paper to your Society setting forth these views. I have since been collecting materials. The theories I hold depend almost entirely on the action of a force which I venture to think has not received the attention it merits. I propose to devote this short paper chiefly to the consideration of the form of energy in question.

It has frequently been said by geologists that discussions regarding the origin of the earth are outside the province of their science. It is difficult to conceive on what grounds this statement rests. How are we to understand the laws which regulate volcanic action, elevation and subsidence, earthquakes, and other kindred phenomena unless we know how the solid earth was formed? Everything must depend on this.

One of the most noteworthy facts brought before students of astronomy and geology is the extraordinary discrepancy in the evidence presented by the two sciences respecting the age of our planet. Geologists are almost unanimously of opinion that at least something like one hundred millions of years must have elapsed since the first appearance of life on our globe. Astronomers would limit the age of the sun himself from beginning to end, to some such period as thirty millions of years. Whatever opinions may be formed regarding the theories which follow, it must be borne in mind that those now received are admittedly incompetent to

explain facts. While the geologist can apparently furnish satisfactory reasons within the limits of his science, his conclusions clash with the requirements of physical astronomy, and *vice versa.*

The nebula theory of Kant and Laplace is, that all the materials out of which the bodies of our solar system were formed were in the beginning of things resolved in their original elements, and filled all the space of the universe in which these bodies now move. This nebulous mass was in an intensely heated gaseous condition. It condensed towards the centre, and in doing so threw off successive rings which on further disruption and condensation assumed the form of planets. The sun himself is now supposed by most astromers to be almost altogether gaseous to the centre (Young.)*

One of the most interesting questions of cosmical physics is how the sun has been radiating heat into space for millions of years without any apparent diminution of the supply. How is this continued outpouring of heat maintained? If we calculate at what rate the temperature of the sun would be annually lowered by the radiation from its surface, we find it to be 2⅓° F. per annum, supposing its specific heat to be that of water, and from 5° to 10° F. per annum, if we suppose it to be the same as most of the substances which compose our globe (Young). It would entirely cool off in a few thousands of years after its formation if it had no other source of heat than that shown by its temperature. It has been attempted to explain the source of its maintenance of heat in two ways. The first is known as the meteoric theory and it is—that the heat of the sun is kept up by the impact of meteors upon his surface. It is considered that though the sun may at some past time have received a large supply of heat in this way, the quantity of meteoric matter now falling is totally inadequate to keep up the supply. The second is the contraction theory which appears to be accepted by most astronomers. As the sun's globe cools off it must contract, and the heat generated by this contraction will suffice to make up the entire loss. Knowing the amount of energy which the sun annually radiates in the form of heat, it has been calculated from the mechanical equivalent of the heat thus radiated, by what amount it must contract to make it up. With the present

* The Sun. International Scientific Series.

magnitude of the sun it has been found that the diameter must contract about 220 feet a year to produce all the heat which it radiates. This rate of contraction diminishes as the sun grows smaller, at such a rate that in five millions of years it will be reduced to one half its present volume. At the present rate of radiation the sun will be as dense as the earth in about twelve millions of years. As to the past, it has been calculated that the heat evolved by contraction from an infinite size or by the falling together of all the parts of the sun from an infinite distance would only have been sufficient to last eighteen millions of years at the present rate of radiation. This is the extreme limit of the heat the sun could acquire. Professor Young says if this hypothesis is true, as it probably is in the main, we are inexorably shut up to the conclusion that the total life of the solar system from its birth to its death is included in some such period as thirty millions of years. No reasonable allowances for the fall of meteoric matter based on what we are now able to observe, or for the development of heat by liquefaction, solidification, and chemical combination of dissociated vapours could raise it to sixty millions.

According to Geikie the argument from geological evidence is strongly in favour of an interval of probably not much less than one hundred millions of years since the earliest forms of life appeared upon the earth, and the oldest stratified rocks began to be laid down.

Let us start on the assumption that the space in which the members of the solar system now move was filled with the matter now forming them. First, as to the constitution of this nebula. We may either assume it to have been one element out of which all substances have been in some way evolved, or we may assume it to have been a mixture of various substances which are themselves elements. Since we have absolutely no proof that the substances known to us as elements can be resolved into a single element, we are hardly justified in making the first assumption. Let us then suppose the nebula to have been composed of different elementary substances, which may have been present in various quantities, and that these substances were uniformly distributed throughout it from centre to surface. Second, as to its condition, we may suppose it to have been in a more or less heated condition or at the absolute zero of temperature. We have already seen that on the assumption that it was in a heated condition we cannot account for such

a maintenance of energy as would satisfy geological requirements, let us assume that the whole was at the absolute zero of temperature. We regard this nebula then as having at first a uniform density throughout, a uniform composition throughout, and at the absolute zero of temperature, *i.e.*, with an entire absence of molecular motion. Now its components cannot have been in a gaseous state, since a gas, to exist as such, requires molecular motion, neither can they have been liquid. They must therefore have been in the solid state of matter. Let us now conceive the whole volume condensing, or growing smaller, by gravitation to the centre of gravity of the whole. It is evident that the matter nearest to the centre of gravity would eventually be the matter at the centre of the sun. Now the heat generated by the collision of a falling body varies as the square of the velocity of that body at the point of impact. But the matter nearest to the centre of gravity would have the least distance to fall, and the force of gravity would there be least. Its velocity therefore at point of impact would be least, so that less heat would be generated by the falling together of any given quantity of matter near to the centre, than would be generated by the falling together of an equal quantity situated at a further distance from it. A body therefore formed in this way would be relatively cold at the centre, and the temperature would increase in a definite ratio towards the surface. The heat generated would not wholly be lost by radiation into space part of it would, by conduction, heat the cooler matter nearer to the centre and would perform work.

On this view of its formation we may then conclude, that the sun was never wholly in a gaseous or plastic state, that its centre at first was cool and solid, that its formation was attended by the gradual development of heat, that as heat was generated the more volatile substances became vapours, that on approaching the surface the heat was much more than sufficient to turn all substances into a gaseous state. As the cooler matter in the interior became heated by conduction, the various materials would on arriving at their successive critical temperatures turn to vapour. In dealing with the question of the maintenance of the sun's energy we have to consider the action of two forces, namely, the contraction of the matter in a gaseous state on its surface, and the expansion from excess of heat of the materials nearer the centre. The question of the duration of the sun's energy

is therefore an extremely complicated one. Any given substance would on arriving at its critical temperature turn to vapour, this vapour would exercise an explosive force on the materials between it and the surface. There are between sixty and seventy elements, and the critical temperature of each one differs. The matter about the surface would be upheaved or disturbed an indefinite number of times. This would continually generate an enormous amount of heat. If this is the case it is an almost hopeless task to compute the duration of the sun's energy. It would depend partly on the proportion in which the various elementary substances were present, and partly on the rate of conductivity of the solid materials deep down from the centre and the resistance offered. Until the greatest possible amount of heat had passed by conduction to the centre, and the vapours formed had performed work, we would not be justified in regarding the sun as a body actually cooling. He is continually parting with the energies, and their expenditure maintains the heat. What is known of the physical constitution of the sun's surface would appear to support this view. There would be a continual storing up of energy, the force of which would be dependent on the amount of resistance to be overcome. The sunspots and faculæ with their periodicity might be caused by the gathering up of the internal forces during seasons, followed by outbursts relieving the internal energies. The eruptive or metallic prominences whose spectra show the lines of sodium, magnesium, barium, iron and other metals, occasionally rise to a height of over 200,000 miles above the chromosphere. The velocity of the motions of these prominences sometimes reaches 200 miles a second. This points to the existence of enormous eruptive forces in the sun's interior. We might regard the sunspots, faculæ, and eruptive prominences as analgous to terrestrial volcanoes, the difference between the solar and terrestrial forces being due to the greater intensity of the former, and to the sun's surface being in an intensely heated gaseous condition.

So far we have dealt with the sun himself and have not considered the mode of formation of the planets. As the nebula condensed heat would be generated by friction between the solid particles themselves while falling, and the more volatile substances would become vapourised, the less easily melted parts would be enveloped in a gaseous atmosphere, and the light particles would not fall so quickly as

the heavier ones. This would occasion a decrease of density at the outer parts of the nebula. Now the formation of the planets can be explained in somewhat the same way as before. The sum total of the rotary motion now existing in the planetary system must have been in the nebula, and as the volume contracted by gravitation towards the centre, its velocity of rotation would constantly increase, so that at last the centrifugal force due to rotation would balance the attractive force of gravity.

The orbits of all the larger planets are approximately in the plane of the ecliptic, and a planet may be regarded as having been formed from masses of the nebula thrown off by centrifugal agencies. On assuming a separate existence from the parent nebula, we must consider its development to have been analagous to that of the sun. There would be a continual falling together of the particles composing it to the centre of gravity of the mass. This condensation would be accompanied by the generation of heat through friction between the particles, and a further differentiation of matter would be occasioned. So that the matter composing satellites would be of less density. The forces at work were exactly the same as those in the sun, but different in degree. We may draw then the following conclusions concerning the earth; that it was never wholly in a plastic or a gaseous state, that its centre was relatively cool and solid and that the temperature gradually increased towards the surface; that through loss of heat by radiation into space a solid crust was formed, and that the cooler matter in the interior became gradually heated through conduction, and the more volatile constituents continually assumed a liquid and vapourous condition. Now these vapours would be obliged to find some outlet. The cooled crust at the surface would crack just in the same way that a boiler full of water, subjected to intense heat and without a safety valve, would crack. Now terrestrial volcanoes are built up along lines of fissure in the earth's crust and almost all the active ones are situated on rising areas. Nearly all can be shown to be thrown up along three well-marked lands or great fissures and the branches proceeding from them. They traverse the surface of the globe in sinuous lines with a general north and south direction and the branches often appear to form connections between the great bands. The first and most important of these bands is nearly 10,000 miles in length. It stretches from near the Arctic Circle at Behring's Straits,

to the Antarctic Circle at South Victoria. The volcanoes in Kamschatka, in the Aleutian Islands, in the Kuriles, and in the Islands of Japan are on this band. The second band starts from near the last in the neighbourhood of Behring's Straits, and stretches along the western coast of the American continent. It is about 8000 miles in length. The third forms a ridge running through the Atlantic Ocean, and divides it longitudinally into two basins. This last chain appears to be verging on extinction, as the number of extinct volcanoes is greater than the active ones, and partial submergence has taken place.

With regard to volcanic phenomena, the two great factors which have to be accounted for are the presence of highly heated rock masses within the earth's crust, and the existence of various vapours and gases in a state of most intimate mechanical but not chemical union with them. (See *Judd on Volcanoes*, page 360.) The active phenomena of volcanoes must be referred to the presence of these gases and vapours.

It may be remarked that the theory advanced explains the linear arrangement of volcanoes, the cause of the intense heat, and the presence of vapours and gases in the earth's interior, without assuming it to be other than a rigid mass.

In investigating the changes and movements which the earth's crust has been subjected to throughout geological time, we must consider the action of two forces. Loss of heat through radiation into space is continually going on from the external portions of the globe. This is accompanied by contraction. On the other hand, access of heat by the materials far down in the interior would give rise to an expanding or explosive force. The extent of this force would depend on the amount of volatile materials among the substances in the earth's interior, the rate of conduction of heat to them, and the resistance to be overcome. In early geological times subterranean action, or rather its effects, may have been less because the crust was not so thick, and the resistance to be overcome would have been less. This may account for the enormous times occupied during the deposition of some of the older formations and the greater uniformity observed among their rocks. If the resistance to be overcome was great the forces would accumulate, but they must at some period find an outlet. The phenomena in

connection with elevation and subsidence, and the formation of mountain chains, may, to a great extent, be explained in this manner. Through extended observations of the rocks in different formations and localities, it has been ascertained by geologists that the subterranean forces are in a state of continual flux over the surface of the globe. They make themselves felt in an area, attain a maximum, and then decline. As regards the formation of mountain chains—The first stage appears to be the opening of a number of fissures running along a line near to that at which, in a long subsequent period, the elevation of the mountain masses takes place. The second stage consists in a general sinking of the surface along the line of weakness and the deposition of great quantities of sedimentary materials. The third consists of a series of movements affecting the parts of the earth's crust on either side of the line of weakness. By these movements a series of tangential strains are produced, which result in the violent up-crushing, folding, and crumpling of the sedimentary materials deposited. Fissures again appear on either side of the original line of weakness from which volcanic outbursts take place. Mountain chains may be regarded as cicatrised wounds in the earth's crust. The subterranean energies after probably accumulating for ages, appear to first find an outlet. Enormous quantities of gases, vapours, and molten rocks are brought to the surface. The forces at last become exhausted and subsidence takes place. The original fissures become closed up and covered with sedimentary deposits of immense thickness. The line of weakness becomes stronger than the adjacent portions of the crust. After long ages the accumulated forces again make themselves felt, elevation takes the place of subsidence, new fissures are formed in the weakest places, the lateral forces come into play, and the sediments overlying the original fissure are upheaved. If we admit the existence of this internal energy, we may have these processes repeated an indefinite number of times over any portion of the earth's crust.

In this paper I do not propose to enter more fully into the subject, but hope, at some future time, to have an opportunity of exhaustively reviewing that branch of dynamical geology which treats of it. I think that by means of this force, a more or less complete explanation of the majority of the most interesting problems presented can be given, especially as regards the causes of the movements of portions of the

earth's crust in the carboniferous age, and the origin of earthquakes, earth-tremors, and earth-oscillations.

It must be remembered that the nebula theory of Kant and Laplace was given to the world before the discovery of the mechanical equivalent of heat. The whole question of the maintenance of the sun's energy would seem to depend on whether the original nebula was in a heated condition or not. Now, the conception of Kant was that the entire universe was filled with this nebulous matter, and that all the heavenly bodies have been evolved from it. If space had been altogether filled with this intensely heated nebulous matter, it is difficult to conceive how heat could have been lost by radiation into space. We know that heat is molecular motion, and we know that molecular motion is caused by intercepted mechanical motion. It is hard to see what *a priori* right we have to assume the presence of intense molecular motion in the original nebula without accounting for it. If we suppose infinite space to have contained an infinite number of almost infinitely small particles at equal distances apart, holding potentially, by virtue of their diffusion, all the energies subsequently evolved, we may assume the entire absence of molecular motion. In its absence the particles must have been in the solid condition of matter. Let them aggregate to centres of gravity, those nearest a centre must at point of impact have acquired less velocity than those falling from a further distance, consequently less heat would be generated, and a body formed thus would be constituted as previously indicated. As to the ultimate origin of these things, science can offer no explanation, but points to the existence of an Infinite and Eternal Power.

ART. III.—*Irrigation and Water Supply in the Australian Colonies.*

By NEWTON E. JENNINGS, M. Inst. C.E., F.R.I.B.A.

[Read April 12, 1888.]

The want of water in many parts of these Colonies for irrigation, as well as for the working of mines, the supply of stock, and domestic purposes is generally acknowledged, it is consequently unnecessary to use any arguments to prove this

The rainfall, so far as the records show, at least in Victoria, is enough to provide a sufficient supply for all purposes if properly distributed; but being intermittent, and the supply from the various creeks, channels and rivers being variable, it cannot be relied on without the aid of some artificial means. Various plans have been proposed, such as the construction of dams or anicuts in rivers or streams to raise the water to channels for distribution ; the supply of these channels by pumping and sinking wells. In the first case, the dams interfere with navigation, and in most natural watercourses the level of water varies so much, that in order to take off water at the driest seasons, the bed of the channel must be so low that the water level in it, for a considerable distance, will be below the level of the country, and a great deal of the water must be lifted, or else what is frequently the best and most profitable land, viz., that near the river, is left without irrigation, and any expenditure on lifting water where it can be avoided diminishes the profits of the cultivator, and thus renders the land less capable of bearing the cost of works necessary to bring it under irrigation, besides also employing labour which could be profitably utilised elsewhere. Water taken off from the natural channels while in flood also contains a very large quantity of silt, and as the rapidity of the flow is retarded in the channels, both because a very rapid flow would injure the banks, and because the inclination of the bed of the canal is reduced as low as possible in order to keep the level of the water above the level of the country as far as possible, the silt is deposited in the channels, thus causing considerable expense for clearing them. There is always also a tendency

for the head sluices to silt up. The cost of raising water by steam power is very great, necessitating a large initial outlay and a constant fixed expenditure for maintenance, which bears a large proportion to the profit of irrigation, and in case of partial failure of the crops, absorbs probably the whole. The use of windmills for pumping no doubt minimises the cost, but there is an element of uncertainty in their use which it is desirable to eliminate as far as possible, and consequently the supply of water should, wherever practicable, be by gravitation. The supply of water from wells occasions great cost in lifting, as a rule, and the supply is small in comparison to the quantity required, and is seldom profitable except for garden crops, or particularly remunerative ones, such as chilies in India.

The direction therefore to which irrigation schemes should turn, is the regulation of the supply of water by storing it before it reaches the rivers and watercourses, thus reducing the risk of floods, and providing against deficiency in times of drought. The distribution of water so stored is a matter for subsequent consideration. In India, the periods of drought are ordinarily about six months. Here, they are usually about the same number of weeks; the proportion of area to storage required here is consequently much less. If storage is provided for the whole of the area under command, the construction of channels for distribution may to a great extent be postponed, as in most cases only a small proportion of the irrigable land is under cultivation; and, although distribution through the natural channels is in most cases wasteful, this waste might at first be disregarded, and the channels could be constructed as more land comes under cultivation and the necessity for economy arises, while the increased area cultivated would enable the necessary funds for the work to be provided. It would very frequently be found also, that the first cost of storing the water, and thus securing a thoroughly satisfactory system of irrigation would be less, and it would very seldom exceed that of constructing weirs or anicuts on rivers of any size. It does not follow that weirs or anicuts are never desirable, but there is little doubt that in most cases storage is preferable, and that endeavours should be made to adopt this system wherever practicable.

The first steps to be taken are, to note the various catchment basins, and to establish rain gauges in suitable places. Considerable care and judgment is requisite in

selecting these situations, and experience in irrigation works is almost indispensable, so that when sites for reservoirs are selected, it may be possible to ascertain correctly the amount of rainfall which will be intercepted by the reservoir. The gauges should be of one pattern, and a uniform system of observation should be adopted in every case. Care should be taken to note the largest rainfall in limited periods, from one hour upwards, as this is of the greatest consequence to enable proper provision to be made for the discharge of the surplus water when the reservoir becomes full, as any deficiency in this respect is the principal source of danger to a reservoir. Notice should likewise be taken of the longest periods of drought and rainfall, and the minimum and maximum rainfall for extended and continuous periods, so that the capacity of the reservoir may be determined—the object being to store sufficient water for any period of drought, together with sufficient to keep up a full supply before or after the drought, during any time that the rainfall alone is insufficient for the requirements.

The next thing to be observed is the determination of the amount of run off corresponding to any particular rainfall in any district. This depends upon the nature of the soil, the slope of the country, the ratio of rainfall to the time in which it falls, whether the land is under cultivation or not, whether it is bare or wooded, and other local peculiarities. Attempts have been made to reduce these to formulæ in particular instances, but so far no one has succeeded in finding any formulæ or constants which would be applicable to different conditions. It is a subject upon which very little is accurately known, and although the gauging of rivers and streams would, to a great extent, solve the question, the ordinary systems of ascertaining the velocity and discharge give results that are by no means reliable. To give one instance, a river was gauged in the ordinary way with floats, and at the same time a series of observations were taken for every 10 ft. in breadth and every 2 ft. in depth, by means of an electric current meter, and the results of the two series of experiments differed by more than 25 per cent. The same sections of the river were used in each case, so that one element of uncertainty was wanting. Probably the latter was about as correct a result as could be obtained for a large river where it was impossible to take the actual quantity of water that had passed in a certain time, and measure it; but there is always some

amount of error in the section of a river taken in a strong current, and with probably a varying level of water. Whether any correct proportion can be arrived at between observations taken in this way, and those taken with floats in the ordinary manner, remains to be seen; but as really reliable results cannot be obtained without a very large number of scientifically conducted experiments, it will probably be a long time before any very great progress is made in the gauging of rivers and streams, and as the cost of observations taken in the way above named is very considerably greater than those taken in the ordinary manner, it is to be feared that this method will not be very generally practised. It would be very desirable if some arrangement could be made by which the various scientific bodies, engineers, and governments would communicate to each other any observations that were made by them, and the results that each deduced from them. Meanwhile the ordinary observations should be made systematically, and by the very best operators obtainable, but even then it will be necessary to be guided a good deal by the opinions of those who from experience are able to estimate approximately the amount of run off in proportion to the rainfall in different districts and under different conditions.

The next thing is to select the sites for reservoirs in connection with the land to be irrigated. For this purpose men of special experience are required, as they must be able to choose sites favourable for the construction of reservoirs, judge approximately whether the rainfall over the catchment area would be sufficient to fill it, whether if filled it would provide for the irrigation of all the land under its command, and to do this they must be able to judge what land would be irrigable from it. The site for a reservoir should be selected to command an area proportioned to its capacity, and the probable length of drought must also be taken into consideration. The depth of the water should be great, so as to reduce the proportion of loss by evaporation. The dam or bund to impound the water should be as short as possible, to save expense. The foundation must be carefully examined to see that it is suitable, and can be made water-tight. Notice must also be taken of what material is available for its construction, so as to determine whether it would be most advantageously constructed of earth or masonry. There must be a satisfactory site for

a weir or overflow, of such a length as would be necessary to carry off the maximum rainfall, and at a suitable level. It is also necessary to see that a suitable channel to carry off the overflow, either exists, or can be constructed. Note must also be made of the land which is likely to be submerged, as in many cases this is an important factor in the practicability of the scheme. It must also be seen how the head works are to be constructed, and what provision can be made for the distribution of the water; and also what facilities, or otherwise, there are for the provision of a complete system of irrigation channels. In addition to all these items, it is necessary to consider whether the quantity of land under command is sufficient to compensate for the construction of the reservoir and channels, and whether the land immediately irrigable would give a return for the cost of the reservoir, and if not, whether the prospects of additional land coming under irrigation are sufficient to compensate for any present deficiency, and the cost of preparing land not previously irrigated for the reception of water must not be lost sight of; and in estimating the probable cost of the work, the accessibility of the site, or otherwise, the means of obtaining the supplies, and method of housing the men employed, must be taken into consideration.

Having determined that on all the foregoing points there is a balance in favour of the scheme, the surveys can be proceeded with. These will commence with contours at every 10 feet in height, so as to make sure whether the anticipations are so far correct as to render it worth while to proceed. This will be a very small expense, and it found satisfactory, the survey would be continued, and intermediate contours to ascertain the exact contents of the reservoir must be taken. For this purpose, contours every 5 feet will ordinarily be sufficient to prove indisputably that the storage capacity is sufficient for the area under command, and that the rainfall will suffice to fill it up to the height proposed for the weir, and to keep up the requisite supply. In case there has not been a fairly accurate survey of the drainage area, it may be necessary to survey this also; but in cases where there is no doubt that the area is more than sufficient, or the rainfall is so heavy as to make certain of a sufficient supply, this may be postponed, unless the site for the weir is restricted in length, in which case it should be done at once, in order to

see that sufficient waterway can be provided for the surplus water.

After dealing with many other important considerations, Mr. Jennings said, with regard to the materials for construction, it will generally be found that if earth is obtainable which is not of too porous a nature, the cost will be less than stone, even if this is available on the spot. The supply of water during construction must also be taken into consideration, as the most satisfactory way of constructing an earthen dam is to water it and roll it in layers of about 6 inches thick, this forms a stronger and more impervious dam than one with only a puddle wall in the centre. It is desirable, if possible, to face the side slope next the water with stone, and consequently it will have to be noted how near the site this can be procured. Stone or brick will be required for the head works, and in most cases for the weir, and the facilities for procuring brick earth must also be investigated, as well as the question of fuel for making bricks. Sometimes a site, which to an unexperienced eye appears most unpromising, turns out particularly desirable; for instance, it may be possible to construct a tunnel which will bring land under command which at first seems inaccessible, or a weir may be constructed by cutting through rock which would be supposed to be too costly, until it is remembered that the stone excavated will be wanted for the head works and for facing the dam. A low spur may run out from a range of hills, and it might appear as if the length of the dam would be excessive, but on investigation it may be found that this spur is just about the height of the dam proposed to be erected. But the discrimination of all these points can only be acquired by practise, united with natural capacity, and no theoretical knowledge will enable a man to select a site.

To sum up, therefore, what is necessary to be done in order to carry out irrigation, and thus raise the value of land many-fold, it would appear desirable that Government should take in hand the storage of water, so as to avoid any jealousies and conflict of interests. The storage should be on high ground, and well up the rivers or streams, as there can be no question as to the right of Government to intercept the rainfall of its own land, and numberless disputes may arise as to the proportion which may be intercepted or taken from a river. All works of this description should be arranged so as to be reproductive

either immediately, or in the near future, and to make them so, either a charge for water should be made according to the quantity used, or the area irrigated, or else a charge on all land under command which could obtain water if the owners or occupiers wished to take it. Whether there should be different rates for pasture and cultivated lands need not just now be discussed. Investigations as to rainfall and discharge of rivers, &c., should be systematically and energetically proceeded with, bearing in mind, that the longer the period during which such observations are made, the more correct will be the results, and they should not therefore be postponed, until any particular work is about to be executed. The country should be examined by thoroughly experienced irrigation engineers, who should select sites which appear appropriate for the construction of reservoirs, and which command land which is, or is likely to come under cultivation. Some preliminary survey of these sites would be desirable, though not essential, as, if irrigation works are required in any particular district, and funds are available, it would be preferable that these should be completely surveyed, and designs and estimates made, and when time permits, or funds are available, preliminary surveys of the rest can be carried out. If experienced men and money are still available, detailed surveys should be made, so that Government may have in their possession complete irrigation schemes for every part of the Colony, and they would be able to proceed at once whenever the necessity arose in any particular district.

Although irrigation only is mentioned in the above remarks, they are intended to apply to the conservation of water wherever required for other purposes, the only modification being as to the command of land. The questions of the distribution of water and construction of the channels for the purpose, and the discussion of the manner in which the revenue should be raised to make the works reproductive, may be left for remark on a future occasion.

ART. IV.—*An Experiment to shew how the Earth is made to Gravitate towards the Sun.*

By T. WAKELIN.

ART. V.—*The Rabbit Question.*

By H. C. WIGG, M.D. Ed., F.R.C.S. Eng.

[Read March 8, 1888.]

The loss and even desolation caused in many parts of this country by the excessive multiplication of rabbits, and the great reward of £25,000 offered by New South Wales for their extirpation, have induced many efforts to discover a cure for the plague.

Of these the most important has been that of M. Pasteur; but his proposed remedy is so uncertain, and at the same time contains such elements of danger, that I have thought it right, as a matter of urgency, to direct the attention of the Royal Society to the subject.

He has discovered that a certain virulent epidemic disease found in France and parts of the Continent, and called the fowl cholera, can be easily communicated to rabbits, and with fatal effect. The poison of this disease he intends to scatter broadcast throughout the colonies, hoping in this manner to destroy the rabbits everywhere.

It is this scheme, the prospects of its success, and the grave risks attending it, that we have to consider to-night.

His plan is to obtain the microbe, which is the effective cause of the disease, to cultivate it in properly prepared infusions, until he has multiplied each single particle of the poison into hundreds of millions, and then to spread it over the ground or over food prepared for the rabbits. The microbe is a living being, extremely minute, and found in

the blood of diseased animals, and it is supposed that there is a special one for each form of disease. There is much difficulty in saying whether it is vegetable or animal.

It is now nearly forty years since microbes were first noticed by Davaine, but their real importance as factors in disease was not recognised thoroughly until 1877, when the celebrated paper of MM. Pasteur and Joubert was read before the Academy of Sciences.

These gentlemen selected anthrax, a disease affecting men and cattle, called in the first case "malignant pustule," and in the second "splenic fever," and showed that in the blood myriads of these little organisms were found, either as slender waving rods, or minute oval spores, or as curled filaments; and also proved that the poison if it existed in these could be cultivated out of the body to an indefinite extent without losing any of its infectious virulence. The method was this:—A neutralised decoction of yeast in water was strained and heated so that all germs in it were destroyed, and a drop of the diseased blood was then placed in it. After a day or two it was full of the microbic growth, and a single drop let fall into a fresh quantity of yeast water produced a second crop, and so on. Of course the latter cultivations give the microbe free from any foreign matter, and it is from these that its form is best studied. Over fifty successive cultivations of the anthrax microbe have been made, and the last one was as virulent as the first. I spoke of the spores of the microbe. While the active form is very sensitive to degrees of heat (the typhoid microbe being very inactive at low temperatures, and the anthrax microbe inactive at high ones), the spores, the seeds as one might call them, which form when the protoplasm of the active plant is drying up, can endure the greatest heat and cold, and could be swept in dust storms from one end of the colony to another, carrying disease and death for thousands of miles.

This should be borne in mind when we consider the proposal to carry on the experiments "safely" here within walled paddocks. We might as well build a post and rail fence to keep out the cholera, or attempt to enclose small-pox within open wire network. Even an island would not secure safety, for the germs might be blown across, or be carried on a boat, or on the clothes and hair of the experimenters. This is one of the great dangers—once admitted, the disease is practically uncontrollable.

There is another point that I will ask you to bear in your minds, as upon it hinges all the value of the experiments held on sheep that we have received by a recent mail, and which are to prove that they could not be attacked by the disease. I quote the words of M. Valery Radot, M. Pasteur's son-in-law, and his recognised organ:—"Easily inoculable and fatal to the ox, the sheep, the rabbit and the guinea pig, splenic fever is very rare in the dog and pig. These must be inoculated several times before they contract the disease, and even then it is not always possible to produce it." He proceeds to state that fowls never take it, but that if they are artificially chilled they do take it easily—(the logic is not mine)—and it proves exceedingly fatal to them.

Now all this simply shows that under varying circumstances of temperature and of intensity of the contagion, the microbe affects different animals, *including those rarely susceptible, and those supposed to be never susceptible to its influence.*

Now for the Rheims experiments, to which so much importance has been attached. A walled-in vineyard of 19 acres (8 hectares) was greatly infested with rabbits, and when they had multiplied so much that there was not sufficent herbage left to keep them from starvation, the amiable old lady to whom the place belonged had them fed each day with hay and dry clover. After some time, however, even she found that it was too much and called in M. Pasteur, who saturated the food with his cholera-poisoned broth, and in two or three days there where hardly any of them left. That is, that famished rabbits within an enclosure and accustomed to artificial food one day find that food poisoned and die accordingly, a result that might safely have been predicted even by non-scientific people, and that is all. One reason why this experiment was not dangerous and, indeed, probably why it was allowed to be performed at all: it was not done in summer, and still less in the fierce heat and far sweeping dust storms of our plain; it was done in the depth of a French winter and amid falling snow.

Again, he inoculates one or more sheep, and allows others to be in the fields with the poisoned rabbits, and says they cannot take it because they did not become infected then, but this, too, was done in the depth of winter; and all know how much the action of zymotic poisons is affected by season and temperature.

Information has been withheld as to what birds it attacks, and whether we may expect to lose our domestic poultry of every kind. It is, however, pretty certain that we should lose our native insectivorous birds, and with them the only restraint we possess over locusts and grasshoppers, which, no longer unchecked as they are now, might become a plague far worse than the rabbits. But it will naturally be said, if such things happen here, how is it that they do not occur in France? The answer to this question is twofold. In the first place, whenever a new disease falls upon virgin soil adapted to its growth, it extends with singular rapidity and virulence, and that whether the disease be in man, as small-pox, or in the earth as thistles and brambles. After a time, however and often after the most frightful ravages, the disease appears to have consumed either the whole or a very large portion of the special material required for its growth, and then either disappears altogether or is confined within moderate bounds.

A most striking example of this is within the memory of all. In 1874 King Thakombau left Fiji to pay a visit to the Governor of New South Wales at Sydney on the occasion of his cession of his realm to the British Crown.

While there he contracted measles, a disease entirely unknown in Fiji, and unfortunately returning home before he was free from the microbes, these minute particles spread to his immediate attendants and grew and multiplied in them, till at last the disease swept like a storm over the islands and no fewer than 40,000 people out of that small population died from its affects. After four or five months the epidemic ceased in its virulent character, and now measles there is scarcely more severe than in Europe.

In the same way, I am informed that the growth of the briar rose in Tasmania, which at one time threatened such great mischief to that colony, is now far more easily controlled than at first; and that thistles in Victoria, partly, no doubt, through the special legislation, but partly also from the exhaustion of certain ingredients of the soil, are becoming greatly restricted in area. Now in France the plants, the animals, and the diseases have, for thousands of years, been adapting themselves to each other, and, if I might use a rather far-fetched simile, they have established a *modus vivendi.*

Here we have new birds, new animals, a virgin soil and new climate conditions. Who can tell what results will

occur when these are brought into contact with a new choleraic disease? Next, besides the fact that in France the choleraic microbe is on a worn out soil—worn out for its own purposes, I mean—we must remember that the frosts and snows and rains of the long winter there are unfavourable to the extension of the microbe, while in that country of small farms, where every range of trees, every growing field, acts as a filter, the conditions are totally dissimilar to those on our vast sweeps of plain, "growing weather" all through the winter, and dust winds raking the country straight down from the rabbit infected fields to the fertile districts of the coast. Is there, then, any certainty as to what would be the result of the introduction here of this poison? There is no certainty. Microbes of some of the most malignant diseases are sterile in certain countries; thus, although typhus fever is endemic in England and Ireland, we have never had one case in Australia. It seems as if it could not live out here. And the poison of the yellow fever of America dies out rapidly in England. So it may be with the chicken cholera in the colonies, but that is only a remote chance, and—no one knows.

Lastly, is there any reason why we should endanger our flocks, our green crops, the whole prosperity of the country, at a word from M. Pasteur? He is a man who has done brilliant scientific work, especially in the diseases of silkworms, the diseases of wine, and the investigation of zymotic disease, but who has the intensely French passion for pushing great ideas further than they will go.

A few brief references to his last great work, the cure of hydrophobia, will illustrate my meaning, and at the same time give us a salutary caution as to believing too much of what we are vaguely and grandiloquently told about his successes. He attenuates the virus of mad dogs by passing it through the systems of a rabbit and a monkey, and then injects with modified cultures, usually from the monkey's brain, into men and dogs as a protective and curative measure. For a year or two all went on well, and one enthusiastic writer even declared that he had "built (upon mad dogs) the eternal temple of his fame." Centres for mad dog vaccination were established at Vienna, Buda-Pesth, and half a dozen other towns; and in March 1886, we find from the *Lancet* that 350 cases had been treated by M. Pasteur, and that but one death had occurred, and that in a case recognised as very serious from the beginning. On 15th

May we find that three persons more have died from one set alone. On 12th June another is dead; on 21st August a boy is dead; on 28th August three more boys, two French and one English; on 4th September a patient dies; on 13th November another, and so on. Then at the end of December the statistics of the Pasteur Institute for the previous 14 months are published, and we find that 31 of the patients are dead; but it is conclusively proved to us in the report by figures (which cannot lie) that during this period M. Pasteur had saved the lives of 163 of his patients. This was a truly great result, and would have excited much admiration had not Professor Peter, of the Hôpital Necker, pointed out from the vital statistics that the average mortality for the whole of France before the discovery of the infallible cure was 30 per annum. And to obtain this result thousands of men and women, many never bitten by rabid animals at all, have been inoculated with the virus and are scattered all through France.

The poison intended for us is now on the ocean, and scarcely a fortnight's sail from our shores. Two of M. Pasteur's assistants are on board the *Cuzco* with large supplies of the choleraic microbe, and perhaps even the germs of other diseases as well. The opinion I offer to you, and which I hope that you, as the leading scientific body in Victoria, will confirm, is that our Government should immediately take steps to make not only the introduction but the use of these things highly penal. It seems to me that in trifling with such diseases we should be rushing blindly towards a precipice; and what lies in the darkness beyond it no man living can say.

ART. VI.—*An Alphabetical List of the Genera and Species of Sponges described by H. J. Carter, Esq., F.R.S., together with a Number of his More Important References to those of other Authors, with an Introductory Notice.*

By ARTHUR DENDY, M. Sc., F.L.S.

Demonstrator and Assistant Lecturer in Biology in the University of Melbourne.

[Read June 14, 1888.]

I.—INTRODUCTORY NOTICE.

Mr. Carter is, and has for a long time, been justly recognised as the oldest and most experienced of all those who have made a special study of the sub-kingdom *Porifera*, or Sponges.

He produced his first paper on the subject, entitled "Notes on the Species, Structure, and Animality of the Freshwater Sponges in the Tanks of Bombay," whilst stationed at Bombay as a surgeon in the army. This paper was published in the "Transactions of the Bombay Medical and Physical Society" of 1847 (No. 8), and was reprinted in the "Annals and Magazine of Natural History (Series 2, vol. I) in the following year. The last paper on the subject which appeared from his pen, on a collection of sponges from the Mergui Archipelago, was published only last year in the *Journal of the Linnean Society of London*, and in the same year he published four other papers in the "Annals and Magazine of Natural History."

In the forty-one years from 1847 to 1887 (inclusive), Mr. Carter has published no less than 125 papers on sponges, a far greater number than any other author. These papers treat of nearly 800 distinct species of sponges, arranged under over 200 distinct generic names. By far the greater number of these 800 species are described by Mr. Carter for the first time.

Although both his first and last papers were published elsewhere, it was a very rare exception for Mr. Carter to publish anywhere except in the "Annals and Magazine of

Natural History," which renders the study of his papers, and the production of such a list as the present, a far easier task than it would otherwise have been.

It is much to be regretted, however, that Mr. Carter has never been able to collect his numerous observations and bring them together in a more coherent form. As it is, they remain scattered about in a state of almost hopeless confusion through the 125 papers above mentioned, and without the assistance of some such list as the present, it is difficult to gain a correct idea of his work.

The greater portion by far of Mr. Carter's work is purely systematic, and consists in the description of new species; but he has also written on the Anatomy and Embryology of the group. He commenced, as we have seen, in 1847, with the study of the Freshwater Sponges, and in the series of papers which he published on this subject, there are some extremely important observations which have hardly attracted as much attention as they deserve. This might be said of a good many of Mr. Carter's observations, and it is possibly due to the fact that they are mostly more or less buried in a mass of purely systematic description, which none but a specialist would ever think of reading. Mr. Carter is a wonderfully careful and accurate observer, and considering the early date at which his observations on *Spongilla* were made, when the study of sponges was practically virgin soil, his results are most remarkable.

Between the years 1849 and 1868 only two papers appeared in his name, but from 1868 onwards, until the middle of 1887, not a year has passed in which he has not published something about sponges. The year 1874 was marked by special activity, for in this year he commenced the publication of his "Descriptions and Figures of Deep Sea Sponges and their Spicules from the Atlantic Ocean, dredged up on board H.M.S. *Porcupine*,"* and in the same year he published two important papers on the Development of Marine Sponges.† The *Porcupine* reports are decidedly the most valuable of Mr. Carter's systematic papers, and the papers on the Development of Marine Sponges are undoubtedly the most important of his more purely biological works.

The progress of the work on the *Porcupine* sponges was interrupted by the publication, in 1875, of the "Notes

* A. M. N. H. Ser. 4. Vol. xiv, p. 207, *et seq.*
† A. M. N. H. Ser. 4. Vol. xiv, pp. 321, 389.

Introductory to the Study and Classification of the Spongida."* The publication of these notes appears to have been suggested to Mr. Carter by the obvious necessity of having some definite system upon which to arrange his numerous species. The plan of the "Notes" was a comprehensive one. They were to consist of three parts, and were to form a kind of general guide to the whole subject, which was rapidly becoming more and more complex. The three parts were to be—(1) Anatomy and Physiology; (2) Proposed Classification of the Spongida; (3) A further Division into Sub-families, Genera and Species, so far as our knowledge extends.

The first part was a general account of the anatomy and physiology of sponges, including those structures, viz., the skeletal elements, upon which the subsequent classification was based. The second part contains Mr. Carter's scheme of classification, which is sufficiently well known to all spongologists, but which has never obtained general acceptance. He himself, however, has adhered to it systematically, and its appearance at this stage was therefore of great importance to the student of his papers. The promised third part, which should have been a kind of coping stone to the whole structure, most unfortunately never appeared. After the publication of the second part, Mr. Carter returned to his work on the *Porcupine* Sponges, the descriptions of which he completed in 1876.

Between 1876 and 1885 there appeared a long series of miscellaneous papers on sponges, which need not here be specially noticed. In 1885, however, an event took place of special interest to Victorian Naturalists, namely, the appearance of Mr. Carter's first paper† on the splendid series of sponges from the neighbourhood of Port Phillip Heads and Western Port, collected and sent to England by Mr. J. Bracebridge Wilson, M.A. Henceforth, Mr. Carter devoted almost all his energy to working out and describing these sponges, and he published a series of fifteen papers upon them in the Annals and Magazine of Natural History. In these fifteen papers he records 211 species and varieties, nearly all of which were new to science and all collected by Mr. Bracebridge Wilson.

After the conclusion of this laborious work, in 1887, Mr. Carter published two noteworthy papers of a more strictly

* A. M. N. H. Ser. 4. Vol. xvi, pp. 1, 126.
† A. M. N. H. Ser. 5. Vol. xv, p. 107.

biological character—the first "On the Position of the Ampullaceous Sac and the Function of the Water Canal-System in the Spongida;"* and the second, "On the Reproductive Elements of the Spongida."† The latter was his last sponge paper in the Annals and Magazine of Natural History, in which he had now been publishing for 41 years. It was succeeded by his report on the sponges of the Mergui Archipelago, in the *Journal of the Linnean Society of London*‡ which, however, Mr. Carter informs me was written so far back as 1883.

As Mr. Carter has at length been obliged by the state of his health to cease working at his favourite subject, and as we shall probably have no more papers on sponges from this indefatigable and able naturalist, it has occurred to me that I might perhaps benefit other naturalists as well as myself by the publication of a complete list of all the genera and species which he has described. These are arranged in alphabetical order, with full references to the places where the descriptions are to be found, and it is hoped that the list will serve as an index to Mr. Carter's papers.

The list of genera and species was compiled whilst I was working in the Natural History Department of the British Museum, and it contains 985 references, every one of which was obtained from the original paper. In addition to the species described for the first time by Mr. Carter himself, which are distinguished by the presence of his name attached to them, the list contains a number of his more important references to the species of other authors. Care has been taken to give all the names exactly in the form in which they appear in Mr. Carter's works, and although subsequent research will probably necessitate considerable modification in Mr. Carter's nomenclature, I have felt that it would be out of place to attempt any such modification here.

It may be of especial interest to Victorian Naturalists to observe, that more than a quarter of the species and varieties mentioned in the list are recorded by Mr. Carter from the neighbourhood of Port Phillip Heads and Western Port.

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* A. M. N. H. Ser. 5. Vol. xix, p. 203.

† A. M. N. H. Ser. 5. Vol. xix, p. 350.

‡ *Jour. Linn. Soc.* Vol. xxi, p. 61.

II.—Alphabetical List.

Acanthella cactiformis	Carter	A.M.N.H. 5,	xv, p. 114
		A.M.N.H. 5,	xvi, p. 364
,, hirciniopsis	,,	A.M.N.H. 5,	xvi, p. 364
,, stipitata	,,	A.M.N.H. 5,	vii, p. 380
Acanthellina parviconulata	,,	A.M.N.H. 5,	xvi, p. 365
,, rugolineata	,,	A.M.N.H. 5,	xvi, p. 365
Acarnus innominatus		A.M.N.H. 4,	vii, p. 273
		A.M.N.H. 4,	xvi, p. 195
Acervochalina claviformis	Carter	A.M.N.H. 5,	xviii, p. 376
Agelas dispar		A.M.N.H. 4,	xvi, p. 195
Alcyoncellum corbicula		A.M.N.H. 4,	xii, p. 367
,, speciosum		A.M.N.H. 4,	xii, p. 367
Alcyonium purpureum		A.M.N.H. 4,	xvi, p. 197
		A.M.N.H. 5,	ix, p. 352
Alectona Higgini	Carter	A.M.N.H. 5,	vi, p. 58
,, Millari	,,	J.R. Micro. Soc., vol. ii,	p. 494
Amorphina anonyma	,,	A.M.N.H. 5,	xvii, p. 49
,, cancellosa	,,	A.M.N.H. 5,	xvii, p. 50
,, megalorhaphis	,,	A.M.N.H. 5,	vii, p. 368
,, nigrocutis	,,	A.M.N.H. 5,	xvii, p. 50
,, stellifera	,,	A.M.N.H. 5,	iii, p. 344
Amorphinopsis excavans	,,	Jour. Linn. Soc., vol. xxi,	p. 77
Aphrocallistes beatrix		A.M.N.H. 4,	xii, p. 359
		A.M.N.H. 4,	xii, p. 451
,, Bocagei		A.M.N.H. 4,	xii, p. 359
		A.M.N.H. 4,	xii, p. 450
		A.M.N.H. 4,	xvi, p. 199
Aphroceras asconoides	Carter	A.M.N.H. 5,	xviii, p. 134
,, syconoides	,,	A.M.N.H. 5,	xviii, p. 135
Aplysina aërophoba		A.M.N.H. 4,	xvi, p. 191
		A.M.N.H. 5,	ix, p. 270
,, cæspitosa	Carter	A.M.N.H. 5,	xviii. p. 282
,, capensis	,,	A.M.N.H. 4,	xvi, p. 192
		A.M.N.H. 5,	viii, p. 110
,, carnosa		A.M.N.H. 4,	xvi, p. 191
,, cauliformis	Carter	A.M.N.H. 5,	ix, p. 270
	P. Acad. Nat. Sci., Philad.,	1884,	p. 202
,, chalinoides	Carter	A.M.N.H. 4,	xvi, p. 192
,, compacta	,,	A.M.N.H. 5,	viii, p. 109
,, compressa	,,	A.M.N.H. 5,	ix, p. 270
,, corneostellata	,,	A.M.N.H. 4,	x, p. 105
		A.M.N.H. 4,	xvi, p. 191
,, cruor	,,	A.M.N.H. 5,	xviii, p. 286
,, fenestrata		A.M.N.H. 5,	ix, p. 272
,, fusca	Carter	A.M.N.H. 5,	vi, p. 36

		A.M.N.H. 5, viii, p. 107
Aplysina incrustans	Carter	A.M.N.H. 4, xviii, p. 231
„ inflata	„	A.M.N.H. 5, viii, p. 108
„ lævis	„	A.M.N.H. 5, xv, p. 204
„ longissima	„	A.M.N.H. 5, ix, p. 271
„ massa	„	A.M.N.H. 5, xviii, p. 284
„ nævus	„	A.M.N.H. 4, xviii, p. 229
		A.M.N.H. 5, xviii, p. 285
„ purpurea	„	A.M.N.H. 5, vi, p. 36
		A.M.N.H. 5, viii, p. 103
Arabescula parasitica	„	A.M.N.H. 4, xii, p. 464
Ascaltis Lamarckii	P. Acad. Nat. Sci., Philad., 1844, p. 208	
Ascetta clathrus		A.M.N.H. 5, xiv, p. 17
Askonema setubalense		A.M.N.H. 4, xii, p. 361
		A.M.N.H. 4, xii, p. 368
Aulodictyon Woodwardii		A.M.N.H. 4, xii, p. 360
		A.M.N.H. 4, xii, p. 452
Axinella atropurpurea	Carter	A.M.N.H. 5, xvi, p. 359
„ chalinoides	„	A.M.N.H. 5, xvi, p. 358
„ „ var. cribrosa	„	A.M.N.H. 5, xviii, p. 377
„ „ „ glutinosa	„	A.M.N.H. 5, xvi, p. 359
„ cinnamomea		A.M.N.H. 4, xvi, p. 196
„ cladoflagellata	Carter	A.M.N.H. 5, xviii, p. 377
„ coccinea	„	A.M.N.H. 5, xviii, p. 378
„ flabellata	„	A.M.N.H. 5, xvi, p. 361
„ meloniformis	„	A.M.N.H. 5, xvi, p. 362
„ pilifera	„	A.M.N.H. 5, xvi, p. 362
„ polypoides	P. Acad. Nat. Sci., Philad., 1884, p. 205	
„ setacea	Carter	A.M.N.H. 5, xvi, p. 359
„ solida	„	A.M.N.H. 5, xvi, p. 362
„ stelliderma	„	A.M.N.H. 5, xvi, p. 360
„ „ var. acerata	„	A.M.N.H. 5, xvi, p. 360
„ villosa	„	A.M.N.H. 5, xvi, p. 361
„ virgultosa	„	Jour. Linn. Soc., vol. xxi, p. 68
„ „ var. massa	„	Jour. Linn. Soc., vol. xxi, p. 68
Axos anchorata	„	A.M.M.H. 5, vii, p. 382
		A.M.N.H. 5, ix, p. 288
„ Cliftonii		A.M.N.H. 4, xvi, p. 198
„ fibulata	Carter	A.M.N.H. 5, vii, p. 383
		A.M.N.H. 5, ix, p. 288
„ flabelliformis	„	A.M.N.H. 5, iii, p. 285
„ spinipoculum	„	A.M.N.H. 5, iii, p. 286
Azorica Pfeifferæ	„	A.M.N.H. 4, xii, p. 439
		A.M.N.H. 4, xii, p. 442
		A.M.N.H. 4, xviii, p. 466
Battersbya Bucklandi		A.M.N.H. 4. xvi, p. 199

Cacospongia cavernosa		A.M.N.H.	4,	xvi,	p. 193
,, sp.		Jour. Linn. Soc.,	vol.	xxi,	p. 64
Carmia macilenta		A.M.N.H.	4,	vii,	p. 276
Carteriospongia caliciformis	Carter	A.M.N.H.	5,	xv,	p. 221
Caulospongia plicata		A.M.N.H.	4,	xvi,	p. 196
,, verticillaris		A.M.N.H.	4,	xvi,	p. 196
Cavochalina bilamellata		A.M.N.H.	5,	xvi,	p. 287
,, digitata var. arenosa	Carter	A.M.N.H.	5,	ix,	p. 281
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„ Carteri		A.M.N.H.	5, vii, p. 86
„ cerebellata		A.M.N.H.	5, vii, p. 88
„ cinerea	Carter	A.M.N.H.	2, iv, p. 82
		A.M.N.H.	5, vii, p. 263
„ erinaceus		A.M.N.H.	5, vii, p. 91
„ fluviatilis		A.M.N.H.	4, xvi, p. 199
		A.M.N.H.	5, vii, p. 93
„ „ var. Parfitti	Carter	A.M.N.H.	5, vii, p. 93
„ fragilis		A.M.N.H.	5, xv, p. 18
„ friabilis		A.M.N.H.	2, iv, p. 83
„ lacustris		A.M.N.H.	5, vii, p. 87
„ Lordii		A.M.N.H.	5, vii, p. 89
„ Mackayi	Carter	A.M.N.H.	5, xv, p. 19
„ Meyeni	„	A.M.N.H.	2, iv, p. 84
		A.M.N.H.	5, vii, p. 93
„ „ var. Parfitti	„	A.M.N.H.	4, i, p. 247
„ multiforis	„	A.M.N.H.	5, vii, p. 88
„ navicella	„	A.M.N.H.	5, vii, p. 87
„ nitens	„	A.M.N.H.	5, vii, p. 89
„ paupercula		A.M.N.H.	5, vii, p. 86
„ plumosa	Carter	A.M.N.H.	2, iv, p. 85
„ sceptrifera		A.M.N.H.	5, vii, p. 93
Spongionella Holdsworthii		A.M.N.H.	4, xvi, p. 193
Stelletta æruginosa	Carter	A.M.N.H.	5, xvii, p. 123
„ aspera	„	A.M.N.H.	4, vii, p. 7
		A.M.N.H.	4, xvi, p. 198
„ australiensis	„	A.M.N.H.	5, xi, p. 350
„ bacillifera	„	Jour. Linn. Soc.,	vol. xxi, p. 78
„ „ var. robusta	„	A.M.N.H.	5. xi, p. 351
		A.M.N.H.	5, xvii, p. 123
„ crassicula	„	A.M.N.H.	5, vii, p, 371
„ discophora		A.M.N.H.	4, xvi, p. 198
„ euastrum		A.M.N.H.	4, xvi, p. 198

		A.M.N.H.	5,	vi,	p. 135
Stelletta geodides	Carter	A.M.N.H.	5,	xvii,	p. 125
,, globostellata	,,	A.M.N.H.	5,	xi,	p. 353
,, Grubii		A.M.N.H.	4,	xvi,	p. 198
,, lactea	Carter	A.M.N.H.	4,	vii,	p. 9
		A.M.N.H.	4,	xvi,	p. 198
,, mammilliformis	,,	A.M.N.H.	5,	xvii,	p. 124
,, ochracea	,,	A.M.N.H.	5,	xviii,	p. 458
,, pachastrelloides	,,	A.M.N.H.	4,	xviii,	p. 403
,, reticulata	,,	A.M.N.H.	5,	xi,	p. 352
,, tethyopsis	,,	A.M.N.H.	5,	vi,	p. 137
Stellettinopsis coriacea	,,	A.M.N.H.	5,	xvii,	p. 126
,, corticata	,,	A.M.N.H.	5,	iii,	p. 348
,, lutea	,,	A.M.N.H.	5,	xviii,	p. 459
,, purpurea	,,	A.M.N.H.	5,	xviii,	p. 459
,, simplex	,,	A.M.N.H.	5,	iii,	p. 349
		A.M.N.H.	5,	xvii,	p. 126
,, tuberculata	,,	A.M.N.H.	5,	xvii,	p. 126
Stelletites haldonensis	,,	A.M.N.H.	4,	vii,	p. 129
Stelospongus cribrocrusta	,,	A.M.N.H.	5,	xviii,	p. 371
,, flabelliformis	,,	A.M.N.H.	5,	xv,	p. 305
,, levis		A.M.N.H.	5,	xv,	p. 303
,, tuberculatus	Carter	A.M.N.H.	5,	xv,	p. 306
Suberites angulospiculatus	,,	A.M.N.H.	5,	iii,	p. 346
,, antarcticus	,,	A.M.N.H.	5,	ix,	p. 350
,, appendiculatus		A.M.N.H.	4,	xvi,	p. 198
,, biceps	Carter	A.M.N.H.	5,	xvii,	p. 117
,, capensis	,,	A.M.N.H.	5,	ix,	p. 350
,, carnosa		Jour. Linn. Soc.,	vol.	xxi,	p. 74
,, carnosus		A.M.N.H.	5,	xviii,	p. 456
,, coronarius	Carter	A.M.N.H.	5,	ix,	p. 352
		Jour. Linn. Soc.,	vol.	xxi,	p. 74
,, domuncula		A.M.N.H.	4,	xvi,	p. 197
		A.M.N.H.	5,	ix,	p. 353
,, fistulatus	Carter	A.M.N.H.	5,	vi,	p. 53
		A.M.N.H.	5,	vii,	p. 370
		A.M.N.H.	5,	ix,	p. 354
,, flabellatus	,,	A.M.N.H.	5,	xvii,	p. 117
,, fuliginosus	,,	A.M.N.H.	5,	iii,	p. 347
		A.M.N.H.	5,	ix,	p. 354
,, globosa	,,	A.M.N.H.	5,	xvii,	p. 116
,, insignis	,,	A.M.N.H.	5,	xvii,	p. 118
,, massa		A.M.N.H.	4,	xviii,	p. 391
		A.M.N.H.	5,	ix	p. 351
,, montalbidus	Carter	A.M.N.H.	5,	vi,	p. 256
		A.M.N.H.	5,	ix.	p. 353
,, montiniger	,,	A.M.N.H.	5,	vi,	p. 256

		A.M.N.H. 5, ix, p. 353
Suberites parasitica	Carter	A.M.N.H. 5, xvii, p. 119
„ spinispirulifer	„	A.M.N.H. 5, iii, p. 345
„ spinispirulifera	„	A.M.N.H. 5, xviii, p. 456
„ stelligerus	„	A.M.N.H. 5, x, p. 124
„ trincomaliensis		Jour. Linn. Soc., vol. xxi, p. 74
„ vestigium	Carter	A.M.N.H. 5, vi, p. 52
„ Wilsoni	„	A.M.N.H. 5, xv, p. 113
		A.M.N.H. 5, xvii, p. 116
„ „ var. albidus	„	A.M.N.H. 5, xvii, p. 116
Sycandra Ramsayi		A.M.N.H. 5, xviii, p. 35
Sycon rhaphanus		Midland Naturalist, vol. iii, p. 195
Sycothamnus alcyoncellum		A.M.N.H. 5, xviii, p. 38
Sympagella nux		A.M.N.H. 4, xii, p. 361
		A.M.N.H. 4, xii, p. 368
Taonura flabelliformis	Carter	A.M.N.H. 5, x, p. 108
Tedania digitata		A.M.N.H. 5, xvii, p. 52
„ „ var. verrucosa	Carter	A.M.N.H. 5, xvii, p. 53
Teichonella labyrinthica	„	A.M.N.H. 5, ii, p. 37
		A.M.N.H. 5, xviii, p. 38
„ prolifera	„	A.M.N.H. 5, ii, p. 35
	„	A.M.N.H. 5, xviii, p. 146
Terpios cœrulea	„	A.M.N.H. 5, ix, p. 355
„ fugax		A.M.N.H. 5, ix, p. 355
Tethea muricata		A.M.N.H. 5, ii, p. 174
Tethya antarctica	Carter	A.M.N.H. 4, ix, p. 412
		Phil. Trans. Roy. Soc., vol. clxviii, p. 287
„ arabica	Carter	A.M.N.H. 4, iv, p. 3
		A.M.N.H. 4, xvi, p. 198
„ atropurpurea	„	A.M.N.H. 4, vi, p. 176
		A.M.N.H. 4, xvi, p. 198
„ casula	„	A.M.N.H. 4, viii, p. 99
		A.M.N.H. 4, xvi, p. 198
„ Cliftoni		A.M.N.H. 5, xvii, p. 122
„ cranium		A.M.N.H. 4, xvi, p. 198
„ „ var. abyssorum	Carter	A.M.N.H. 4, xviii, p. 405
„ „ „ australiensis	„	A.M.N.H. 5, xvii, p. 127
„ „ „ infrequens	„	A.M.N.H. 4, xviii, p. 405
„ „ „ robusta	„	Jour. Linn. Soc., vol. xxi, p. 79
„ dactyloidea	„	A.M.N.H. 4, iii, p. 15
		A.M.N.H. 4, ix, p. 82
		A.M.N.H. 4, xvi, p. 198
		Jour. Linn. Soc., vol. xxi, p. 79
„ lyncurium		A.M.N.H. 4, iv, p. 7
		A.M.N.H. 4, xvi, p. 198
		P. Acad. Nat. Sci., Philad., 1884, p. 208

Tethya merguiensis	Carter	A.M.N.H. 5,	xi, p. 366
		Jour. Linn. Soc., vol.	xxi, p. 80
„ sphærica		A.M.N.H. 5,	ix, p. 360
„ stipitata	Carter	A.M.N.H. 5,	xviii, p. 460
„ zetlandica	„	A.M.N.H. 4,	ix, p. 417
Tetilla polyura		A.M.N.H. 4,	xvi, p. 198
Textiliforma foliata	Carter	A.M N.H. 5,	xvi, p. 288
Thalysias massalis	„	A.M.N.H. 5,	xvii, p. 50
„ subtriangularis		A.M.N H. 4,	xvi, p. 196
		Phil. Trans. Roy. Soc., vol.	clxviii; p. 287
„ tener	Carter	Jour. Linn. Soc., vol.	xxi, p. 70
Thecophora semisuberites		A.M.N.H. 4,	xvi, p. 198
Thenea fenestrata		A.M.N.H. 5,	xi, p. 362
„ muricata		A.M.N.H. 5,	xi, p. 362
„ Wallichii		A.M.N.H. 5,	xi, p. 362
Theonella Swinhoei		A.M.N.H. 4,	xii, p. 438
		A.M.N.H. 4,	xii, p. 441
Thoosa socialis	Carter	A.M.N.H. 5,	vi, p. 56
		A.M.N.H. 5,	vii, p. 370
Tisiphonia annulata	„	A.M.N.H. 5,	vi, p. 140
„ nana	„	A.M.N.H. 5,	vi, p. 138
„ penetrans	„	A.M.N.H. 5,	vi, p. 141
Trachya durissima	„	A.M.N.H. 5,	ix, p. 357
„ globosa	„	A.M.N.H. 5,	xvii, p. 121
„ „ var. rugosa	„	A.M.N.H. 5,	xviii, p. 457
„ horrida	„	A.M.N.H. 5,	xviii, p. 457
„ pernucleata	„	A.M.N.H. 4,	vi, p. 178
		A.M.N.H. 4,	xvi, p. 198
Trachycladus lævispirulifer	„	A.M.N.H. 5,	iii, p. 343
		A.M.N.H. 5,	xvi, p. 357
Trichogypsia villosa	„	A.M.N.H. 4,	viii, p. 1
Trichostemma hemisphericum		Midland Naturalist, vol.	iii, p. 195
Trikentrion læve	Carter	A.M.N.H. 5,	iii, p. 294
		A.M.N.H. 5,	x, p. 114
„ muricatum		A M.N.H. 5,	iii, p. 293
Tuba acapulcaensis	Carter	A.M.N.H. 5,	ix, p. 279
„ armigera		A.M.N.H. 4,	xvi, p. 194
		A.M.N.H. 5,	ix, p. 278
„ digitalis		A.M.N.H. 4,	xvi, p. 194
		A.M.N.H. 5,	ix, p. 277
„ Eschrichtii		A.M.N.H. 5,	ix, p. 365
„ lineata		A.M.N.H. 5,	ix, p. 277
„ longissima		A.M.N.H. 4,	xvi, p. 194
„ plicifera		A.M.N.H. 4,	xvi, p. 194
		A.M.N.H. 5,	ix, p. 365
„ poculum	Carter	A.M.N.H. 5,	xv, p. 403
„ sororia		A.M.N.H. 4,	xvi, p. 194

		P. Acad. Nat. Sci., Philad., 1884, p. 204
Tuba tortolensis		A.M.N.H. 4, xvi, p. 194
Tubella paulula		A.M.N.H. 5, vii, p. 96
„ recurvata		A.M.N.H. 5, vii, p. 98
„ reticulata		A.M.N.H. 5, vii, p. 97
„ spinata	Carter	A.M.N.H. 5, vii, p. 96
Tubulodigitus communis	„	A.M.N.H. 5, vii, p. 367
Uruguaya corallioides	„	A.M.N.H. 5, vii, p. 100
Ute capillosa		Phil. Trans. Roy. Soc., vol. clxviii, p. 288
Vioa Carteri		A.M.N.H. 5, ix, p. 354
„ Johnstonii		A.M.N.H. 4, xvi, p. 197
		A.M.N.H. 5, ix, p. 354
		A.M.N.H. 5, xviii, p. 458
„ Schmidtii		A.M.N.H. 5, ix, p. 354
Verticillites anastomans		A.M.N.H. 5, xiv, p. 27
„ helvetica		A.M.N.H. 5, xiv, p. 27
Wilsonella australiensis	Carter	A.M.N.H. 5, xvi, p. 366
„ echinonematissima	„	A.M.N.H. 5, xix, p. 210
Xenospongia patelliformis		A.M.N.H. 4, xvi, p. 198
		A.M.N.H. 5, ix, p. 357

EXPLANATION OF ABBREVIATIONS.

A.M.N.H.—Annals and Magazine of Natural History.

J.R. Micro. Soc.—Journal of the Royal Microscopical Society.

Jour. Linn. Soc.—Journal of the Linnean Society of London—Zoology.

P. Acad. Nat. Sci., Philad.—Proceedings of the Academy of Natural Sciences of Philadelphia.

Phil. Trans. Roy. Soc.—Philosophical Transactions of the Royal Society of London.

ART. VII.—*On Two New Fossil Sponges from Sandhurst.*

By T. S. HALL, M.A.

(Communicated by A. DENDY, M. Sc., F.L.S.)

[Read July 12, 1888.]

Both the specimens, figures of which I append, were found at Ironbark, Sandhurst, Victoria, in rock of the Landeilo flag age. The spicules are of a dead black colour, and are preserved in a soft, cream-coloured, slightly micaceous schist.

Genus.—Protospongia. *Fam.*—Protospongidæ (Hinde). *Sub-Order.*—Hexactinellidæ.

Hinde defines Protospongia as follows:—"Form of sponge unknown. The portions preserved consist either of detached spicules, or fragments of a delicate spicular framework, formed of a single layer of four-rayed spicules of various dimensions. The larger spicules are arranged so as to form regular squares, which are divided by smaller spicules into smaller squares, and these are again sub-divided, so that the surface of a fairly complete specimen resembles lattice-work."

PROTOSPONGIA RETICULATA (N. SP., FIGS. 1 AND 2).

Description.—The specimen is nearly circular in outline, and probably in its living state had a somewhat spherical form. Its length is about 7 cm. and its width about 6 cm. The spicules are cruciform, the four rays crossing at angles varying from 70° to 90°, the variation from the usual rectangular form of Hexactinellid spicules being probably due to compression. The spicules are of various sizes. The larger ones (the rays of which measure 3·5 mm. in length and ·5 mm. in diameter) are so placed that they enclose squares, and smaller spicules, the rays of which measure 1·5 mm. in length, are placed inside these larger squares so as to divide each into four smaller squares. Numerous smaller cruciform spicules are scattered about in an apparently irregular manner, and it does not appear that the subdivision of the squares is carried as far as in typical

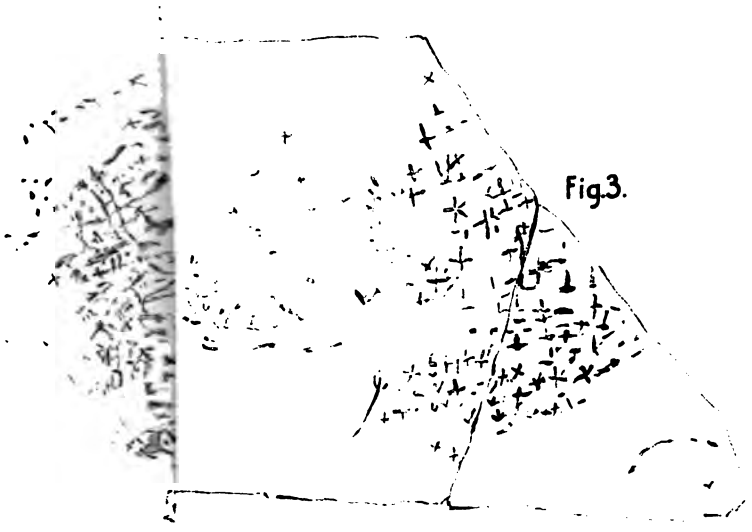


Fig.3.

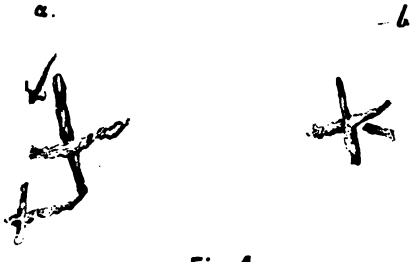
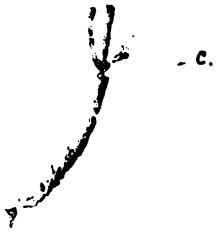


Fig.4.



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Protospongia. With this exception, the measurements agree very closely with those of a Lower Cambrian form, *P. Hicksi* (Hinde), the figures of which are given in his "British Fossil Sponges," though the description, unfortunately, has not yet appeared.

The specimen was found by Mr. J. E. G. Edwards, of Sandhurst.

P. Cruciformis (n. sp., Figs. 3 and 4).

Form of sponge unknown. The fragment preserved is somewhat oblong in shape, its width being about 3·5 cm. and its length about 4·5 cm. The spicules are cruciform in shape, the length of the rays being 2 mm. and their diameter ·5 mm. They are placed end to end, so as to form approximate squares. Smaller and irregularly placed cruciform spicules, the rays of which are about ·75 mm. in length, are present in places. In one instance a broken ray, about 1·5 mm. in length, lying in the angle of one of the larger spicules, suggests the possible presence of a fifth ray at right angles to the plane in which the other two lie. At one side of the specimen occurs a spicule about 6 mm. long. This has three rays at one end, forming obtuse angles with it, and may possibly be an anchoring spicule.

The specimen more nearly agrees with Protospongia than with any other form, though the apparent absence of two sizes of squares suggests that it may possibly be of a new genus. A more perfect specimen would, however, be required for the foundation of one.

The specimen was found by Mr. J. O. Liddle, of Sandhurst, and is in the Melbourne University Biological Museum.

My warmest thanks are due to Mr. Dendy for his advice during the preparation of the paper, and for the loan of books on the subject, which I was unable elsewhere to procure.

DESCRIPTION OF FIGURES.

Plate 4.

1. P. reticulata, natural size.
2. Portion of 1 magnified 4 times.
3. P. cruciformis, natural size.

4a. *4b.* *4c.* Spicules from 3 magnified 4 times.

ART. VIII.—*Preliminary Notes on the Structure and Development of a Horny Sponge (Stelospongus flabelliformis).*

By ARTHUR DENDY, M. Sc., F.L.S.

Demonstrator and Assistant Lecturer in Biology in the University of Melbourne.

[Read July 12, 1888.]

I.—ANATOMY AND HISTOLOGY.

(*a*) *External Characters.*—This sponge, which was discovered by Mr. J. Bracebridge Wilson, M.A., near Port Phillip Heads, Victoria, and briefly described by Mr. H. J. Carter in the Annals and Magazine of Natural History, consists of a stout cylindrical stalk terminating below in a basal expansion for attachment to the substratum and above in a broad, compressed, but thick frond. Along the upper margin of the frond is a single row of large oscula. The character of the surface of the frond is subject to considerable variations. On both sides it usually exhibits a number of prominent, branching and anastomosing ridges, enclosing a number of concave depressions. The entire surface of the sponge is more or less thickly encrusted with particles of sand; these are, however, more abundant over the ridges than in the depressions, and the latter are characterised by a minutely reticulate appearance, due to the presence of the inhalant pore-areas. The pores are enormously abundant all over the depressed portions of the surface, but are absent on the ridges.

(*b*) *Skeleton.*—The skeleton is composed of a rather irregular reticulation of cylindrical horny fibres, branching and anastomosing freely. The fibres are rather slender and the meshes between them are wide. It is easy to distinguish primary and secondary fibres. The primaries are long and rather stouter than the secondaries, about 0·096 mm. in diameter. They radiate towards the surface of the sponge, and end in the sandy incrustation. They are easily

distinguished by the presence in them of numerous foreign bodies, which form an axial core, surrounded and held together by the spongin. The secondary fibres are short and contain no foreign bodies, they run in various planes and unite together adjacent primary fibres, meeting them at various angles ; they may also branch and anastomose *inter se.*

Thus the skeleton is thoroughly typical in structure and arrangement, and essentially the same as that of the ordinary bath sponge, only much coarser.

In the stalk, the skeleton is more strongly developed, and hence the latter acquires a tougher and denser character than the remainder of the sponge.

(*c*) *Canal System.*—The inhalant apertures, or pores, are thickly scattered all over the depressed areas on the surface of the sponge. These larger areas are themselves subdivided into a great number of smaller ones, which are the true pore-areas, comparable to the pore-sieves of *Phakellia* and *Myxilla.* Each pore-area is irregularly rounded or oval in outline, and measures about 0·19 mm. in its longer diameter. Each one overlies a subdermal cavity, and contains five or six oval or rounded pores, averaging 0·05 mm. in diameter.

The subdermal cavities are hollow spaces in the ectosome, corresponding in size and shape to the pore-areas which they underlie, and communicating with the exterior by means of the pores in the latter. Adjacent subdermal cavities are separated from one another by anastomosing vertical walls of tissue, constituting the bulk of the ectosome, and each communicates below with an inhalant space or canal. Thus each subdermal cavity receives the water from the exterior through five or six distinct apertures (the pores) in its roof, and passes it on through a single (?) aperture in its floor into a large inhalant channel. Just as a number of pores lead into one and the same subdermal cavity, so also a number of subdermal cavities lead into one and the same inhalant channel. There is, however, a good deal of variation in the arrangement of the inhalant canal system, and it would probably be difficult to find two cases in which it was exactly alike. The large inhalant channels, into which the subdermal cavities directly open, lead, in their turn, into an irregular system of much smaller, more or less lacunar channels, whose ultimate ramifications open into the flagellated chambers.

Numerous flagellated chambers open out of one and the same ultimate inhalant lacuna. The chambers themselves are more or less spherical sacs, about 0·04 mm. in diameter, with two wide apertures of about equal size placed at opposite poles, whereby they communicate on the one hand with an ultimate inhalant lacuna, and on the other with an ultimate exhalant lacuna. Several chambers may lead into one and the same ultimate exhalant lacuna.

Both the inhalant and exhalant apertures of the flagellated chambers are usually drawn out into short and relatively wide cameral canaliculi, much as in *Euspongia officinalis*, as figured by Schulze.

The exhalant canal system is partly lacunar and partly composed of very definite tubular canals (the oscular tubes) with proper walls of their own, separable from the remainder of the choanosome. The ultimate exhalant lacunæ, into which the flagellated chambers open, collect together and finally discharge their contents into branches of the oscular tubes. Each oscular tube is a perfectly definite, wide, cylindrical canal, with distinct walls, and leads vertically upwards to a wide circular osculum situated on the upper margin of the sponge.

In connection with the exhalant canal system, I must also mention certain spherical cavities lying in the neighbourhood of the oscular tubes, and containing each a single large embryo. These cavities appear now to be entirely closed and cut off from the remainder of the canal system of the sponge, but it is possible that they are really portions of the exhalant canal system, specially modified to serve as receptacles in which the embryos are lodged during a large portion of their development.

(d) Histology of the Soft Tissues.

A. *The Ectosome.*—The ectosome forms an external layer of varying thickness all over the surface of the sponge. Owing to the presence in it of a large amount of sand, especially abundant on the raised ridges, it is very hard and tough, and forms an excellent protection against the attacks of parasitic crustaceans, worms, &c., to which sponges are very subject.

The outermost layer of the ectosome is formed by an extremely thin and delicate epidermis, most readily visible in the pore-areas, where the sand grains are absent. The nuclei of the epidermic cells may be easily distinguished in the transparent pore-bearing membrane ; they are round or oval in shape, and about 0·0048 mm. in diameter.

Beneath the epidermis a very large proportion of the ectosome is occupied by the sand grains above mentioned, but surrounding these is a considerable quantity of mesodermal tissue. This is for the most part made up of cystenchyme, but stellate mesoderm cells are also present.

The name *Cystenchyme* has been applied by Sollas to a peculiar form of tissue not uncommonly met with in the ectosome of sponges. In *Stelospongus*, the cystenchyme cells are oval or subglobular in shape, measuring about 0·024 mm. in diameter, and the nucleus is small and granular. The protoplasmic strands which connect the nucleus to the cell wall are best seen in unstained preparations mounted in glycerine. They are then seen to form a network, branching and anastomosing *inter se*. In balsam preparations, owing doubtless to the greater transparency, the protoplasmic strands are not nearly so distinct.

I may mention here that cystenchyme occurs also in the choanosome of *Stelospongus*, but to this point I shall return later on.

The stellate mesoderm cells of the ectosome appear to be thoroughly typical. They may be seen investing the grains of sand in a kind of delicate network, the individual cells being mutually connected by long delicate processes. The body of the cell is somewhat granular, and the nucleus is oval and of moderate size.

(B.) *The Choanosome.*

(1) The walls of the inhalant and exhalant canal system.—It will be convenient to give these the first consideration because of their close relationship to the ectosome, from which they cannot be sharply separated.

The larger or proximal portions of the inhalant canal system are provided with special walls of mesodermal tissue. The true nature of this lining membrane is difficult to determine. In sections it is seen to consist of a very much vacuolated, gelatinous substance, composed more or less of cystenchyme, but in parts becoming fibrous.

The ultimate inhalant lacunæ have no special mesodermal walls, but here the nuclei of a lining epithelium can be easily detected in thin sections.

The ultimate exhalant lacunæ also have no special mesodermal walls, but are lined by a delicate flattened epithelium. The larger exhalant canals, or oscular tubes, are, however, provided with most distinct walls, which can

be dissected out from the underlying tissues with great ease. These walls are membranous and fairly tough, and they are continued from the oscular tube along its various larger branches as a distinct lining membrane.

The wall of the oscular tube is seen in transverse section to be made up of the following layers, from within outwards ; (*a*) Furthest from the lumen of the tube, a thick, rather irregular layer of very much vacuolated, gelatinous tissue ; (*b*) A much thinner layer of deeply staining, fibrous tissue, in which the fibres are closely packed and arranged circularly around the oscular tube. (*c*) A continuous layer, only about one cell thick, of cystenchyme.

I have no doubt that the wall of the oscular tube is completed on the inside by a delicate, flattened epithelium, but I have not succeeded in demonstrating its presence.

(2) The walls of the embryo-containing cavities.—Whatever view may be adopted as to the relationship of the embryo-containing cavities to the exhalant canal system, it will be convenient to describe the structure of their walls in this place.

The only ovum which I have observed, previous to the commencement of segmentation, lies in a small cavity about 0·1 mm. in diameter, situate in the innermost part of the gelatinous layer of the wall of an oscular tube. This cavity has a special wall composed of fibrous tissue, with elongated nuclei. I have not detected any lining epithelium, although some of the nuclei observable may possibly belong to a delicate epithelial layer.

The large embryo-containing capsules are doubtless developed by growth of the small ovum-containing capsules. The walls of the large capsules are, however, very much more highly developed, and consist of two very distinct layers :—(*a*) A fibrous layer, and (*b*) a lining epithelium. The fibrous layer is very dense next to the lining epithelium, but further in it becomes looser, and is broken into by large lacunar spaces. It is composed of circularly arranged fibres, each consisting of a greatly elongated, fusiform, granular cell, with a deeply-staining, oval nucleus in the centre. The fibres are so densely packed in the outer part of the layer, next to the lining epithelium, that the outlines of the individual cells can no longer be distinguished ; but further in the cells lie further apart, and the tissue partakes more of the nature of a compact, stellate mesoderm.

The lining epithelium of the embryo capsule is very peculiar, and, so far as I am aware, entirely different from anything which has hitherto been described in sponges. It is composed of a single layer of enormous polygonal cells. These cells, although flattened, are thick. In the youngest embryo capsule they average about 0·072 mm. in diameter, but up to 0·12 mm. in diameter in older ones, and they are about 0·024 mm. in thickness. The body of the cell is finely granular, and each contains in its centre a very large, flattened, oval nucleus, enclosing a number of deeply staining granules. In transverse sections, the outer surfaces of the cells are very often seen to be indented, and these indentations would appear to correspond in some way to the upper portions of the outer layer of cells of the embryo, which in life are closely connected with the epithelial layer of the embryo capsule. In transverse sections also the body of the cell is seen to be granular throughout, but the granules are very much finer around the nucleus than towards the periphery of the cell. The cell always has a very definite bounding wall on its outer and sometimes also on its inner surface; but frequently its inner surface, which in life is pressed against the fibrous layer of the embryo-capsule, exhibits no such wall. In sections the nucleus sometimes appears solid and sometimes as a hollow vesicle provided with a distinct wall and enclosing a granular substance.

These large epithelial cells very readily become detached from the underlying fibrous layer of the capsule, and sometimes remain adherent to the embryo when the latter is removed from the mother sponge.

Owing to its relationships to and intimate connection with the outer layer of cells of the embryo, and for certain other reasons, I believe this peculiar lining epithelium of the embryo capsule to be nutritive in function.

(3) The walls of the flagellated chambers.—The walls of the flagellated chambers are, of course, composed of collared cells, but these cells exhibit certain very interesting details in structure.

Last year Professor Sollas showed* that in certain sponges the collars of the collared cells (*choanocytes*) are united together at their margins by a continuous membrane, which forms a kind of inner lining to the chamber. I have

* Article Sponges in the Encyclopædia Britannica. Ed. ix.

been able to demonstrate the existence of this connecting membrane, which for the sake of convenience we may term Sollas's membrane, in the flagellated chambers of *Stelospongus.*

The collared cells are arranged at about equal distances all around the chamber, but they are interrupted at the proximal pole by the inhalant aperture, and at the distal pole by the exhalant aperture. They are not all of the same size, but largest around the inhalant aperture, and gradually diminishing towards the exhalant aperture, around which they are smallest. Each cell consists of a cylindrical collum or neck with a large nucleus lying in its slightly expanded base (the body of the cell). The collum projects into the chamber, and gives support to the delicate membranous collar, which is rather longer than the collum, and considerably wider at its summit. Thus the whole cell, including the collar, has somewhat the shape of a dice-box, being narrower in the middle than at the two ends. I have not been able to trace any definite outline to the body of the cell, which is imbedded in a highly granular ground substance, but the nuclei are always very conspicuous. The flagella cannot be detected in my preparations, being entirely shrivelled up, or possibly retracted when the sponge was placed in spirit.

The margins of the collars are all connected together by a continuous delicate membrane (Sollas's membrane), which lies in a plane at right angles to the long axis of the collared cell. This membrane is seen in thin vertical sections as a fine thread running from collar to collar. If, however, the sections be taken in a plane more or less parallel to Sollas's membrane, then the latter frequently appears as an irregular network of delicate transparent strands, shrivelled up and distorted by the action of reagents, but easily recognisable lying within the chamber.

From what has been said of the sizes and arrangement of the collared cells in each chamber, it will be seen that the membrane joining their margins will not run parallel to the wall of the chamber, but will be furthest from it at the proximal or inhalant pole, and nearest to it at the distal or exhalant pole. At the proximal pole, in fact, the membrane is widely separated from the wall of the chamber, while at the distal pole, the two became confluent. Hence the membrane has the form of a cup, whose concavity is turned towards the exhalant aperture of the chamber.

(4) The general mass of mesodermal tissue in which the canals, flagellated chambers and other structures are imbedded.—

The flagellated chambers are pretty closely packed together in the choanosome, and together with the various branches of the canal system, make up the greater part of its bulk. Hence the amount of fundamental or ground tissue in which they are imbedded is not very great. What there is is packed full of minute, highly refringent granules, fairly evenly distributed through it. Imbedded in this granular matrix may be observed, here and there, small nucleated cells of irregularly rounded outline, doubtless the amœboid cells of authors. This ground tissue appears to agree thoroughly with that which Schulze has described as existing in Euspongia.

(5) The spongoblasts and other mesodermal cells surrounding the fibres.—

In most parts the skeleton fibres are surrounded by a sheath of ordinary stellate or slightly fibrous connective tissue. In some places, however, the stellate mesoderm cells are specially modified as *spongoblasts* or glandular cells whose function it is to secrete the spongin of which the horny fibre is composed. The spongoblasts form a layer one cell thick around the fibre. Each one is a somewhat club-shaped, slender, elongated, granular mesodermal cell, about 0·048 mm. long; one end is drawn out into a long, gradually tapering neck, and the other, broader end is usually rounded off, but sometimes stellate, and contains a spherical nucleus. The whole cell is frequently more or less bent or contorted. Its long axis, however, always lies approximately at right angles to the surface of the fibre against which its narrow end abuts. There is commonly, if not always, a layer of stellate mesoderm outside the layer of spongoblasts, and it is easy to see that the spongoblasts themselves are simply slight modifications of the ordinary stellate type of cell.

II.—Development.

My observations on the embryology of *Stelospongus* are as yet very imperfect, for all the embryos which I have as yet found are in pretty much the same stage of development. Of this particular stage there is, however, an abundant supply, and it presents some very remarkable features.

The ovum, of which I have found one example in my sections, appears in section as a somewhat oval cell, lying in a fibrous capsule, as described above. The body of the ovum is granular and deeply staining. At one pole there is a large, oval nucleus, with a very definite wall, and right up against the wall at the outer pole of the nucleus there lies a small, spherical nucleolus. Within the nucleus there is a quantity of coarsely granular protoplasm, chiefly aggregated towards the pole remote from the nucleolus. The nucleolus stains deeply and is almost if not quite homogeneous.

The embryos, which are abundant, are spherical solid bodies, about as large as small peas. When the surface of the embryo is examined with a pocket lens, it exhibits a minutely punctate appearance, due to the presence of an immense number of shallow pits, somewhat polygonal in outline and separated from one another by low ridges. Each one of these pits is the imprint of one of the large epithelial cells of the embryo capsule.

In sections, the embryo is seen to consist of an outer layer of rather large, closely packed cells, enclosing a central mass of clear, transparent, jelly-like substance, in which immense numbers of amœboid wandering cells are imbedded. The outer layer, or ectoderm, consists of a single layer of large, sac-shaped or somewhat flask-shaped cells, measuring about 0·024 mm. in length. The narrower portion, or neck of the cell is on the outside of the embryo, and the swollen portion projects inwards into the gelatinous intercellular substance, and from its inner extremity the cell frequently sends out a few short, slender, protoplasmic processes, resembling pseudopodia. The body of the cell is coarsely granular, but less so in the neck than in the swollen portion. The greater part of the neck is, however, occupied by a large, spherical nucleus, which appears to consist of a hollow vesicle containing a few deeply staining granules. The nuclei of adjacent cells are all arranged at just about the same level, so that they form a continuous row, which is a very conspicuous feature in transverse sections of the embryo.

Frequently the outer end of the neck of each ectodermal cell may be seen to be drawn out into a short, slender protoplasmic process, which extends to the outer surface of one of the large, investing epithelial cells and attaches itself to it. Thus the ectodermal cells of the embryo often appear to be suspended from the outer surfaces of the investing epithelial cells by short protoplasmic processes. Judging

from the number seen in a single transverse section, it would appear that each of the large epithelial cells may have a hundred or more sac-shaped ectodermal embryonic cells hanging from its lower surface.

The unusual length of time during which the embryo remains within the mother sponge, and the great size to which it attains, necessitate some special arrangement whereby it can be nourished. The peculiar relations of the ectodermal cells of the embryo to the investing epithelium, and the very unusual character of the latter, cause me to believe that the investing epithelium has for its function the nutrition of the embryo, and that this is effected by the absorption of nutriment through the necks of the ectodermal cells.

Sometimes, however, the ectodermal cells exhibit no prolongations of the neck, but are smoothly rounded off at the free end, and such cells may form a continuous layer over a considerable area.

The entire mass of the embryo, within the ectodermal layer, is made up of a clear, jelly-like matrix, in which immense numbers of large, amœboid wandering cells are imbedded. These cells appear somewhat larger than the ectodermal cells, but there is very strong reason for believing that they are simply ectodermal cells which have left their place in the outer layer and, becoming amœboid, wandered into the central jelly. Between the large amœboid cells very delicate branching stellate cells may sometimes be seen. The amœboid cells may put out pseudopodia in all directions, but often they appear to be radially elongated, and more or less bi-polar. I think my sections show conclusively that the amœboid cells are derived from the ectodermal layer. They agree at first in all essentials with the cells of the latter, and in those parts where the ectodermal cells have the clearer, outer end of the neck evenly rounded off—and thus present a characteristic feature—a precisely similar clear rounded neck may often be seen in the cells immediately beneath the ectoderm.

The amœboid cells are from the first highly granular, and at what I believe to be an early stage in the proceedings each one has a spherical nucleus, resembling that which occurs in the ectodermal cells. Sometimes the amœboid cells lying near the outside of the embryo have two or three nuclei, and very rarely also even the ectodermal cells appear to have two nuclei. At a later stage, the entire cell is seen to

have become indistinct in outline, and in place of one large cell we have an aggregation of very many minute spherical bodies, each with a dark spot in its centre, but each aggregation still retains the form of the original amœboid cell. In the same sections which exhibit this condition many of the amœboid cells appear to have become rounded off, and their contents have arranged themselves around a central cavity, so that we have a hollow chamber lined by small spherical cells. These chambers I believe to be the young flagellated chambers. They are certainly very different in structure from the flagellated chambers of the adult sponge, and only about half the size; but this difference is readily explained by their embryonic condition. I have not been able to trace the development of the chambers any further, nor is it to be expected that the collars and flagella would be developed before the young sponge was set free and required them.

Coincidently with the formation of the chambers in the manner just described, a slit-like invagination appears on the surface of the young sponge, and it is chiefly, if not solely, around this invagination that chamber formation takes place. This invagination I believe to be the commencement of a communication between the chambers and the outside. Unfortunately, I have only obtained a single embryo which is sufficiently advanced to show the formation of the flagellated chambers and the slit-like invagination, but I see no good reason for doubting the normality of the phenomena above described.

It thus appears that the flagellated chambers in *Stelospongus* are formed by the breaking up of large amœboid cells, exactly as described by Mr. Carter in the development of the gemmules of *Spongilla*.

ART. IX.—*The Active Volcano on Tana, New Hebrides, with some remarks on the Cause of Volcanic Action.*

With Map and Plates 5, 6, 7 and 8.

By FREDERICK A. CAMPBELL, C.E. (Melb.)

[Read 11th October, 1888.]

Tana is one of the southern islands of the New Hebrides group, and lies approximately in 20° south latitude and 170° east longitude. It is about 30 miles long by 12 miles wide, and is densely covered with the most luxuriant tropical vegetation. The interior is occupied by a range of mountains which rises to a height of about 2500 feet, and so far as I know, has never yet been explored. The shores are partly fringed by a narrow coral reef, outside of which the water deepens rapidly, and good anchorage is difficult to find. There is only, or more correctly speaking was only until recently, one harbour on the island, viz., Port Resolution, a picturesque basin about one mile in diameter, situated upon the south-eastern side and opening towards the north.

Four-and-a-half miles to the north-west of this harbour, the active volcano Mount Yasur, is situated. It rises from a plain or wide flat valley which separates the elevated land of the Port Resolution district from the still more lofty ranges of the interior. A ridge 400 or 500 feet high extends from the harbour towards the volcanic cone, descending as it approaches that hill, the summit of which stands about 500 feet above the plain beyond and 700 feet above the sea level.

The volcanic district, that is the area over which are scattered traces of volcanic action, past and present, is about 20 square miles in extent, being a belt about 2½ miles wide, extending from the sea coast outside and to the south of Port Resolution, for a distance of seven miles to the active cone of Mount Yasur.

Plate 5 gives a vertical section drawn through this part of the island. Plate 6 gives a plan of this district upon which I have marked the approximate position of the various volcanic phenomena.

Commencing at the most southerly, these may be briefly catalogued as follows :—

Hot springs on the outer sea coast.

A deposit of contorted ropy lava on the same coast about one mile farther north.

Hot springs on the south-east side of Port Resolution, temperature about 100°.

Hot springs on the west side of Port Resolution, temperature about 200°.

Stratified beds of a sort of argillaceous sandstone, closely allied to pumice stone, and used by sailors for holystoning the decks, alternated with this, bands of cinders or slag. These are seen in the cliffs on each side of the entrance to the harbour, where the sea has exposed a vertical section to view.

Hot beds of white clay occur further to the west. These are soft, when opened with a stick emit jets of sulphurous steam, and have a temperature ranging up to 200° Fah.

A small lake exists to the southward of this, the water of which has a temperature of about 100° Fah.

Beds of sulphur lie close to the active cone, as well as a large deposit of lava which stands piled up to a height of about 200 feet, the precipitous face of which indicates that it has issued forth in a very viscous state.

Just at the foot of the mount and beyond it, there lies a beautiful fresh water lake about one-and-a-half miles long by half-a-mile in width. It is fed by one of the largest streams in the island, it has no outlet to the sea, but disposes of its superfluous waters by pouring them continuously into large crevices on that edge which is next to the volcanic cone.

The cone itself is composed of loose scoriæ lying at an angle of about 2 to 1, with hardened lava protruding here and there, and blocks of a more porous nature strewn upon its surface.

The top of the cone is occupied by two distinct craters of about equal size and form, one, the farthest west being active, the other extinct. The active crater is an oval basin about 700 feet long, 500 feet wide, and 150 feet deep. Two large and one smaller vents occupy the bottom, the larger ones being about 50 feet in diameter; from these and from cracks in the sides of the crater, jets of steam continually rise, and the ground everywhere is almost too hot to touch. Between the eruptions, the crater is empty of lava, and there is nothing but the hissing steam jets to indicate the existence of the tremendous forces imprisoned below.

Plate 7 gives a general view of the volcano from the north-east, the entrance to Port Resolution being shown on the extreme left.

There are two other active volcanoes on this group, and another in the Santa Cruz Islands immediately to the north, particulars of which I have given in a paper recently read before the "Royal Geographical Society of Australasia," and entitled "Some Coral and Volcanic Islands of the Western Pacific."

Whilst Mount Yasur resembles these, in that it is subject to eruptions at times on a very large scale, it differs very materially from them in that, while they rise to about 3000 feet above sea level, it has an elevation of only about 700 feet, while their normal state is that of a steady emission of smoke without noise, that of Yasur is one of rapid and regular, but comparatively feeble, explosions.

The Eruptions of Mount Yasur.

In the paper previously referred to, I have given the fullest details obtainable from various sources upon this part of the subject; it will be necessary, however, to recapitulate the leading points, and for the sake of presenting the history of this volcano in the clearest form, I have arranged the various records in chronological order:—

1774.—Cook and Forster.—This is the first record of the volcano. They remark that it threw up prodigious quantities of fire and smoke; that the explosions resembled claps of thunder, followed by a rumbling noise, and that showers of rain appeared to increase its violence. Hot springs and solfatarras were observed by them on the west side of the harbour, and it was noticed that when the eruptions were violent, the quantity of steam emitted from these springs was considerably increased. The interval between the eruptions was observed to be about five minutes.

1793.—Labillardière observed it from a distance, and remarks that columns of smoke rose to a prodigious height, and after traversing a great space, sunk as they grew cooler.

1840.—Aneityum Native.—A very violent eruption occurred about this year.

1862.—Turner records the intervals between the eruptions as from six to eight minutes.

1865.—Brenchly notes the intervals as about the same as Turner, and observes that the eruptions were more violent than usual during the months of January, February and March.

1872.—Campbell.—When visiting the group at that time, I noted the period between eruptions as varying from four to six minutes, according to the state of the weather. In the winter, when the trade winds were blowing and the weather was fine, there would be hardly a minute of difference in the intervals for weeks together. So far as I recollect, there was no perceptible difference in the intervals during the day as compared with those during the night, that is, the temperature did not seem to affect the eruptions.

1873.—Markham notes the eruptions as occurring every three minutes.

10th January, 1878 Neilson.—A tremendous eruption took place, accompanied by an earthquake and an upheaval of the land. A fortnight afterwards, this was repeated on a smaller scale.

April 1888. Watt.—A violent eruption took place, accompanied by an earthquake, and further upheaval.

The eruptions of this volcano may be conveniently divided into three different classes :—1st., The normal or quiescent ; 2nd., the violent ; 3rd., the paroxysmal. I will treat of these in the order named :—

1st.—The Normal or Quiescent State.

The interval between the eruptions is on the average from four to five minutes. When particularly sluggish, the interval increases to as much as eight minutes. A longer time than this without eruptions has never been noticed, according to the Rev. Thos. Neilson, who was resident for 14 years at Port Resolution, and therefore is a competent authority on the subject.

The sound accompanying each eruption is a loud report, followed by a more continuous rumbling, almost exactly like that produced by the firing of a heavy piece of ordnance, and this is heard to a distance of about 30 miles. A sensible vibration of the sound is felt at Port Resolution with each explosion. The material ejected from the crater consists of red hot lava in the form of spherical bombs, large irregular fragments, in some cases as large as a horse, clouds of fine volcanic dust appearing as densely black smoke, and steam. The heavy fragments are thrown to a height of 500

or 600 feet above the crater, falling back into it again, or carried by the wind over the leeward edge. The clouds of steam and smoke generally assume a globular form, and carried away by the wind, distribute upon the space over which they pass quantities of fine volcanic dust.

Accompanied by Mr. Neilson, I visited the crater, and spent some time in watching the phenomena of its eruptions. It was difficult, however, under the circumstances to make calm and reliable observations. The noise was so appalling and the situation so unusual and exciting that one could well be pardoned for not collecting much accurate and reliable data. The eruptions were too close also to be studied properly, and the general impression received was of a simultaneous explosion, earth tremor, and projection high into the air of a torrent of stones, lava and smoke. Between these principal explosions however, molten lava occasionally surged up in the vents, accompanied by small explosions and the ejection of fragments to a short distance around, very much as is described as occurring at Stromboli in the Mediterranean. The different vents appeared also to exhibit a certain variety in their action, one of them throwing the lava higher and with a loud explosion, the other throwing up the larger masses with a less degree of force, as if they tapped the reservoirs beneath at points of different pressure.

2ND.—THE VIOLENT STATE.

At certain periods the volcano becomes more than usually active, the eruptions being not only more frequent, but more forcible. A greater quantity of material is ejected, and it is thrown to a greater height, much of it falling outside the crater, and rolling down the sides. Referring to this state Mr. Neilson writes:—"Its period diminishes sometimes to 45 or 50 seconds, and during rainy and thundry-looking weather, it will thud away for a fortnight or three weeks at this rate, shaking the whole island at every explosion and being heard to a distance of 50 or 60 miles away.

Mr. Forster, the companion of Captain Cook, more than a century ago, noticed that rainy weather increased the violence of the eruptions, and so did Mr. Brenchly in 1865. I observed that the rapidity and violence was increased not only when the weather grew sultry, and bad weather approached, but also during rain and for a short time after rain.

3RD.—THE PAROXYSMAL STATE.

At irregular intervals of time, this volcano and district have been the scene of eruptions upon a scale of unusual violence. Traces of vast disturbances in the past are evident, and in historic times, there are records of three such occurrences, regarding which I have been able to collect the following particulars:—

1840 (Approximately).—Upon the authority of a native of Aneityum, a tremendous eruption took place on Tana about this time, and quantities of pumice stone floated across from Tana to Aneityum.

January 10th, 1878.—Very full details of this eruption have been furnished to me by Mr. Neilson, who was living then at Port Resolution. During the night of the 9th of January the wind had been blowing hard, and the morning broke very dark and lowering. About 9 o'clock a.m. the most severe shock of earthquake known since the islands were settled took place, lasting some four or five seconds. Simultaneously with this, the western side of Port Resolution was raised with an even tilting motion, and a large mass from the face of the cliffs near the entrance was hurled forward into the sea, causing a tremendous disturbance, and projecting a wave some 40 feet high against the land on the opposite side.

The eastern side of the harbour escaped almost entirely, only a few rocks being displaced, but the western side was raised to the extent of about 25 feet. The whole of the district between the harbour and the volcano was shaken and rent by fissures which occurred almost every 100 yards. Several natives fell into these, but were able to extricate themselves before being engulphed. For several weeks afterwards, this district emitted dense volumes of steam from these fissures, and the active cone of "Yasur" presented the appearance of having been partly shaken down, a flow of ashes having taken place westward and into the lake, partially encroaching upon it.

About a fortnight afterwards, another earthquake and eruption took place, with a second upheaval of the western side of Port Resolution to a height of seven feet more.

The volcano itself after about three weeks' display of tremendous eruptive force, gradually resumed its normal state of activity.

Two facts recorded by Mr. Neilson in connection with this outbreak are worthy of notice. 1st. The earthquake which accompanied the first great eruption on the 10th, and was felt so severely at Port Resolution, was not felt at all 12 miles away. 2nd. That on the same day as the eruption on Tana, a violent hurricane was raging at Efate 100 miles to the north, which island is on the direct line which passes through the various foci of volcanic activity in the group.

April 1888.—Intelligence arrived recently of another outbreak of volcanic force on Tana, during April of the present year. Full particulars are not yet to hand, but it appears that the eruption was again accompanied by an earthquake and further upheaval of the western shore of Port Resolution, which fine harbour is now reported to be destroyed, nothing larger than a boat being able to gain admittance.

So far as could be observed from the sea, no great change had occurred in the appearance of the volcano itself, which in June had again resumed its normal quiescent state.

Somewhere about the same time, the volcano on Ambrim also burst forth with great violence, and a great hurricane was raging in the north of the group; whether these three events were synchronous or not, I cannot say.

Having now placed before you all the particulars regarding this volcano available at the present time, I wish to draw your attention to certain conclusions which may, I think, be naturally based upon the facts already recorded. These conclusions refer to the position of the present focus of activity, the depth at which the explosions causing the eruptions take place, and the connection between the phase of eruption and the state of the weather.

On examining the plan of the district, it will be seen that the present focus of activity is at the extremity of the area affected by volcanic heat and pressure, the whole region between it and the sea appears to have been raised at a comparatively recent date, and has no connection with the main island, which is of a different geological formation. It would also appear probable, from the nature of the deposits, that either Port Resolution itself has been at one time an immense crater, or that there has been one about its entrance, The bed of twisted lava on the eastern outside coast-line would appear to strengthen this idea, as it is difficult to believe that it could have flowed from the present position of the volcano, with Port Resolution intervening in a direct line between.

It may I think also be concluded, from a comparison of the two beds of lava, the one referred to and the other close to the present cone, that the internal heat at Tana is diminishing. It may reasonably be assumed that the lava flow near Mount Yasur is the most recent, and this from the way in which it stands piled up presents the appearance of having issued forth in a much more viscous state than that on the outer coast-line.

With regard to the depth below the surface at which the force causing the eruption is generated, two circumstances will assist in determining this approximately. The first is the accompanying earthquake, the second the area of surface upheaved in the violent shocks. Every eruption is attended by an earthquake, which varies in force precisely as the eruption varies in magnitude, and they occur always at the same instant; these earthquakes are confined to the volcanic district, the most severe ever felt, that of 1878, not being noticeable 12 miles away. The origin, therefore, could not have been deep-seated, it being very evident that the deeper the origin, the more widespread and uniform would be the result. In the absence of accurate data as to the direction, the angle of emergence, and the relative force at different distances from the centre, no precise estimate can be made. The depth of the focus of an earthquake which shook the whole of Italy was fixed by Mr. Mallet as being about six or seven miles. The origin of the Tana earthquakes and eruptions must therefore be very much less than this. The fact also of the area upheaved or bulged upwards during the eruptions of 1878 and afterwards, being so small, would appear to strengthen the view that the origin of the disturbance is not deep-seated, for it is quite impossible to conceive of a small portion a few hundred yards in extent being lifted, the land around remaining *in situ*, without bringing the generating force very close indeed.

The connection of volcanic eruptions with the atmospheric pressure has frequently, and especially in late years, received attention, without however establishing it as a matter of fact. This no doubt is due to the incompleteness of the observations, and to the fact that only in connection with such volcanoes as Stromboli, and that on Tana, where the eruptions are so frequent, is it possible to take a sufficient number of observations to be of any value in this matter.

Professor Judd, the latest writer on this subject, referring to Stromboli, says :—" Whether the popular idea, that

the outbursts of Stromboli are regulated by atmospheric conditions has any foundation, is still open to grave doubt. It seems to be certain, however, that during the autumn and winter the more violent paroxysms of the volcano occur, and that in summer the action which takes place is far more equable and regular." This means, I take it, that during that portion of the year exposed to the greatest fluctuations of atmospheric pressure, the volcano exhibits the greatest variety in the phases of its eruptions.

That the Tana volcano is affected in this way, is open to very little doubt at all.

Almost every visitor from Captain Cook onward has noticed and recorded this fact. I had personally the opportunity of observing the eruptions during all kinds of weather, and the increase in their rapidity and force was invariable when the weather became unsettled, stormy weather approached, on the fall of rain and for a short time after rain. The most violent eruptions have always occurred during the summer, that is the hurricane months; in the winter when the trade winds are blowing, and day after day the weather does not vary, the eruptions are very regular and comparatively feeble. Mr. Neilson after an experience of its habits for 14 years reports in the same terms.

Although a series of accurate observations of the eruptions taken in connection with those of a barometer would be of great value in throwing light on this subject, the general law of the connection of the condition of the atmosphere and the nature of the eruptions may be considered as established, so far as this volcano is concerned.

It would be impossible to study the working of this remarkable engine of nature for any length of time without being led to consider the cause of it all, the reason of its regularity and of its irregularities, and the various peculiarities attending it. The inquiry is full of interest but beset with difficulties, so that theories must be advanced and received with caution in the limited state of our present knowledge.

I will, however, conclude this paper with an attempt to account for the varied and remarkable performances of the volcano under discussion.

The generally accepted theory of volcanic action is that it is due to three causes :—1st. The existence of molten lava beneath the surface of the earth's crust; 2nd. The percolation

of water upon these heated layers; 3rd. The escape through fissures or vents of high pressure steam, caused by the contact of the water with the molten lava.

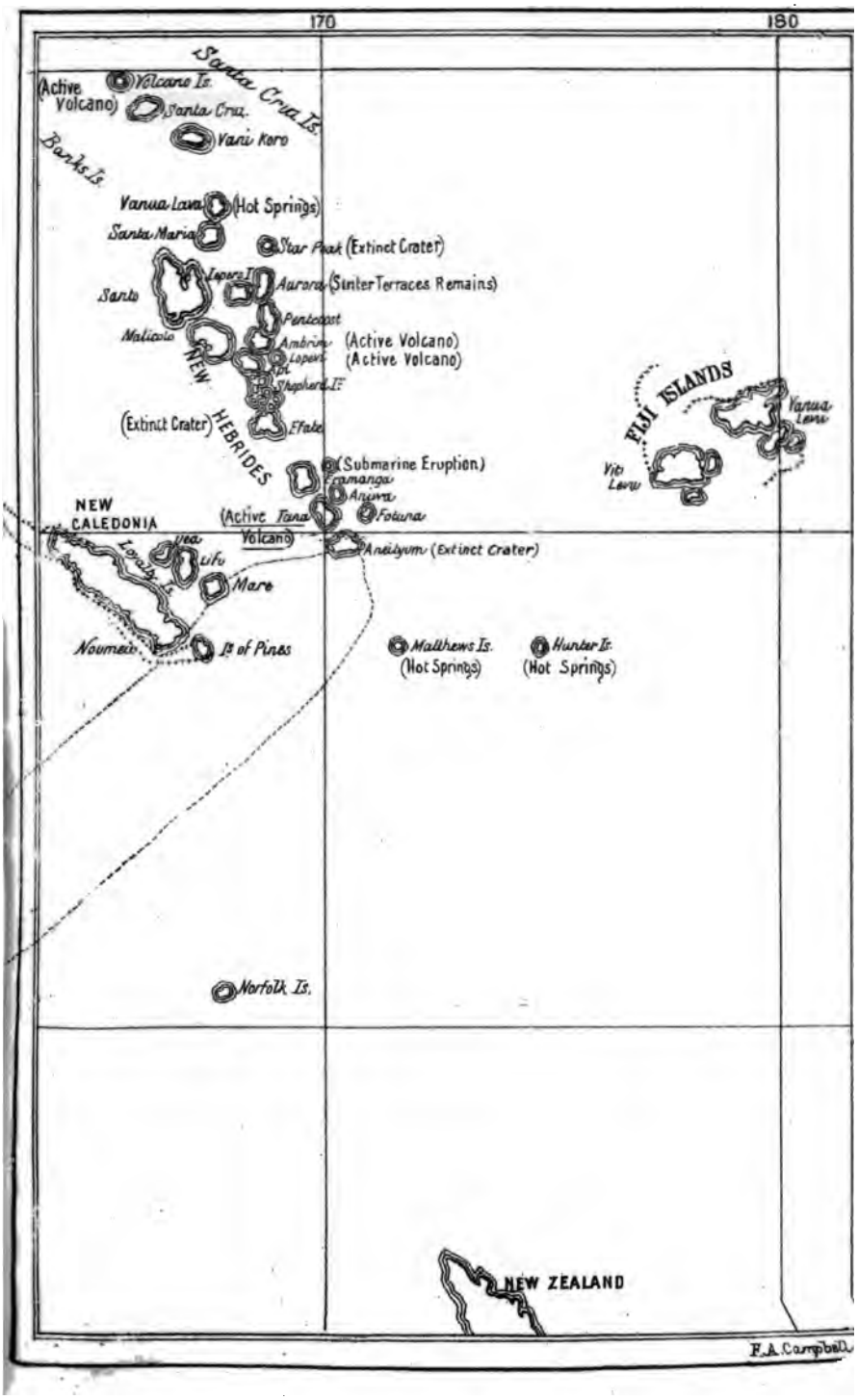
Professor Judd considers that the immediate cause of eruptions is due to the escape of high pressure steam through the lava, in the form of bubbles which rise and burst at or near the surface, much as would be the case if porridge were to be boiled in a tube. Now this does not appear to satisfy the conditions required for explaining the various phases of the eruptions of Mount Yasur, particularly the normal quiescent regular state.

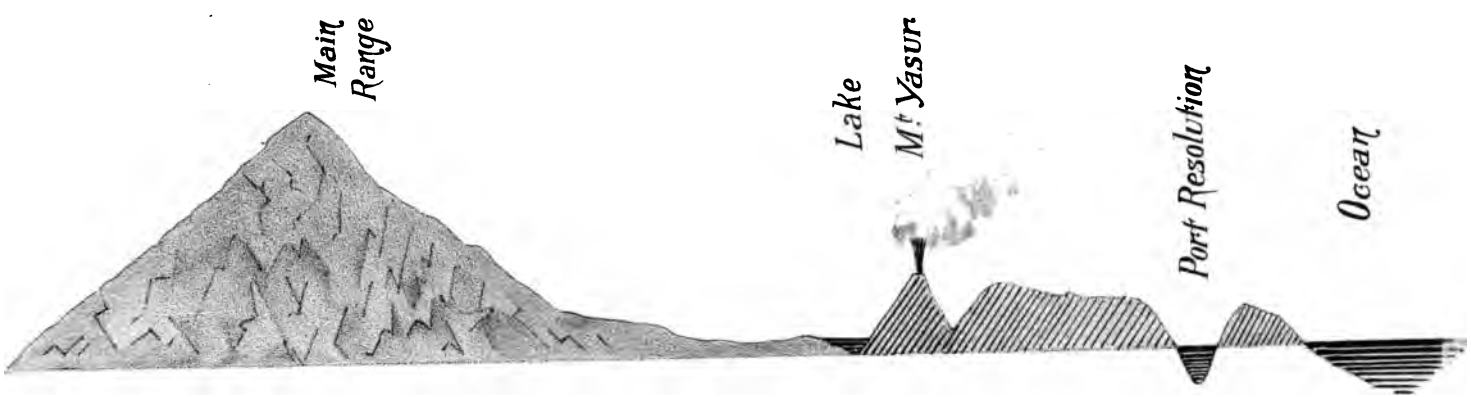
With the aid of a diagram (plate 8), let me suggest another method, or it might be called a modification of the above.

I look upon the Tana volcano as a lava geyser or a natural underground steam machine, depending for its peculiarities upon the nature of the arrangements of the water supply, steam chamber, and outlet vent. I assume a lake of molten lava (F), which at normal atmospheric pressure maintains in the vent (C) a column at about a constant level. (D) is a space above the lava, filled with steam. The vent is tapped at a point below that at which the lava stands by a cave or fissure (B), into which the water supply from the lake (A) finds its way. This water coming into contact with the heated lava is turned into steam, which on the pressure becoming sufficiently strong to overcome the resistance, is forced under the column in the vent and ejects it with great violence. On the escape of the steam, the lava rises again immediately to its former level in the vent, and the steam making process goes on as before. The heat, the atmospheric pressure, and the water supply being constant, there is no reason why this process should not go on for ever with the most perfect regularity.

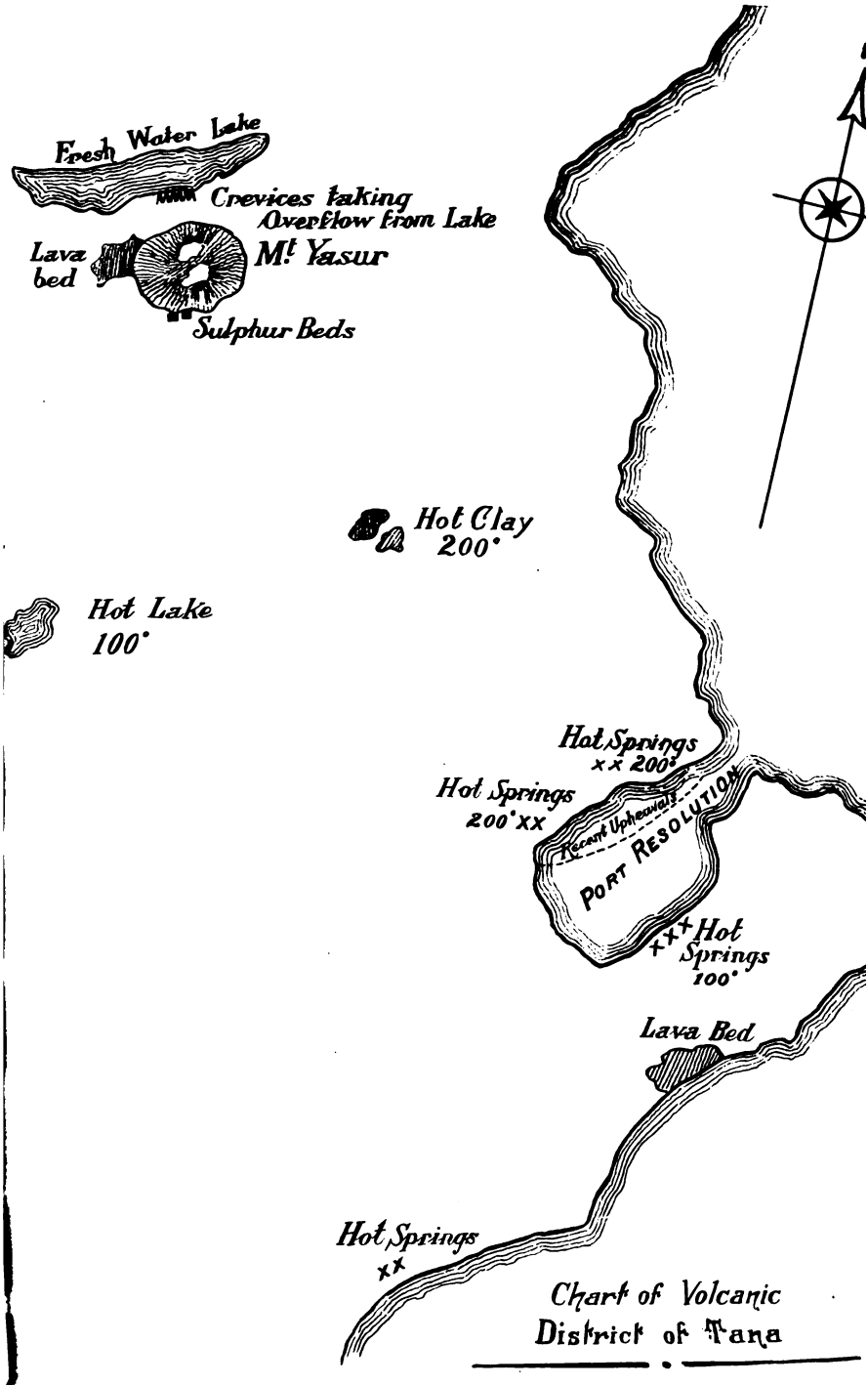
I may state that I have tested this arrangement practically, and have succeeded in obtaining the result as stated above, *i.e.*, a perfectly regular spasmodic ejection of fluid from a pipe by the steady admission of steam at a point below its surface.

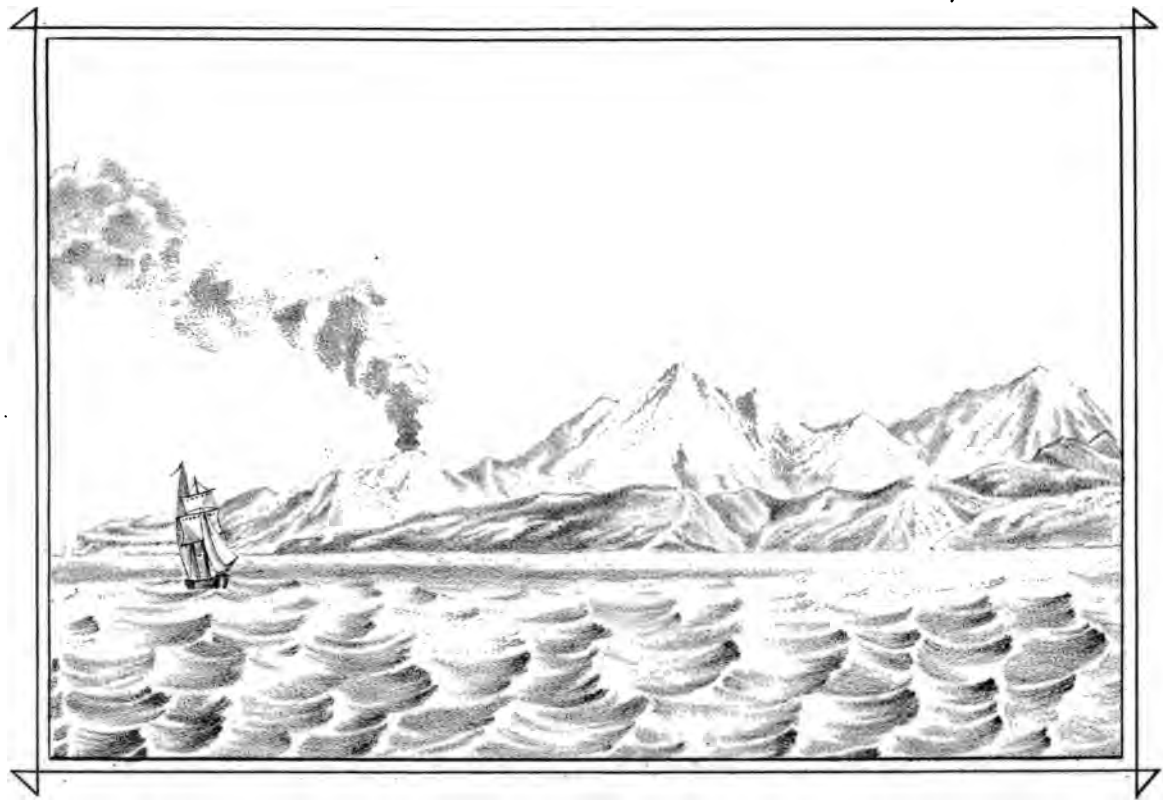
As the molten lava would also contain steam at considerable pressure, or water ready to turn to steam, absorbed from the ocean, the effect of the escape up the vent of a considerable volume of free steam, and the emptying of what I have called the steam chamber, would be to cause a sudden decrease of pressure and an additional quantity of steam to be formed which would aid in the ejection of the lava.

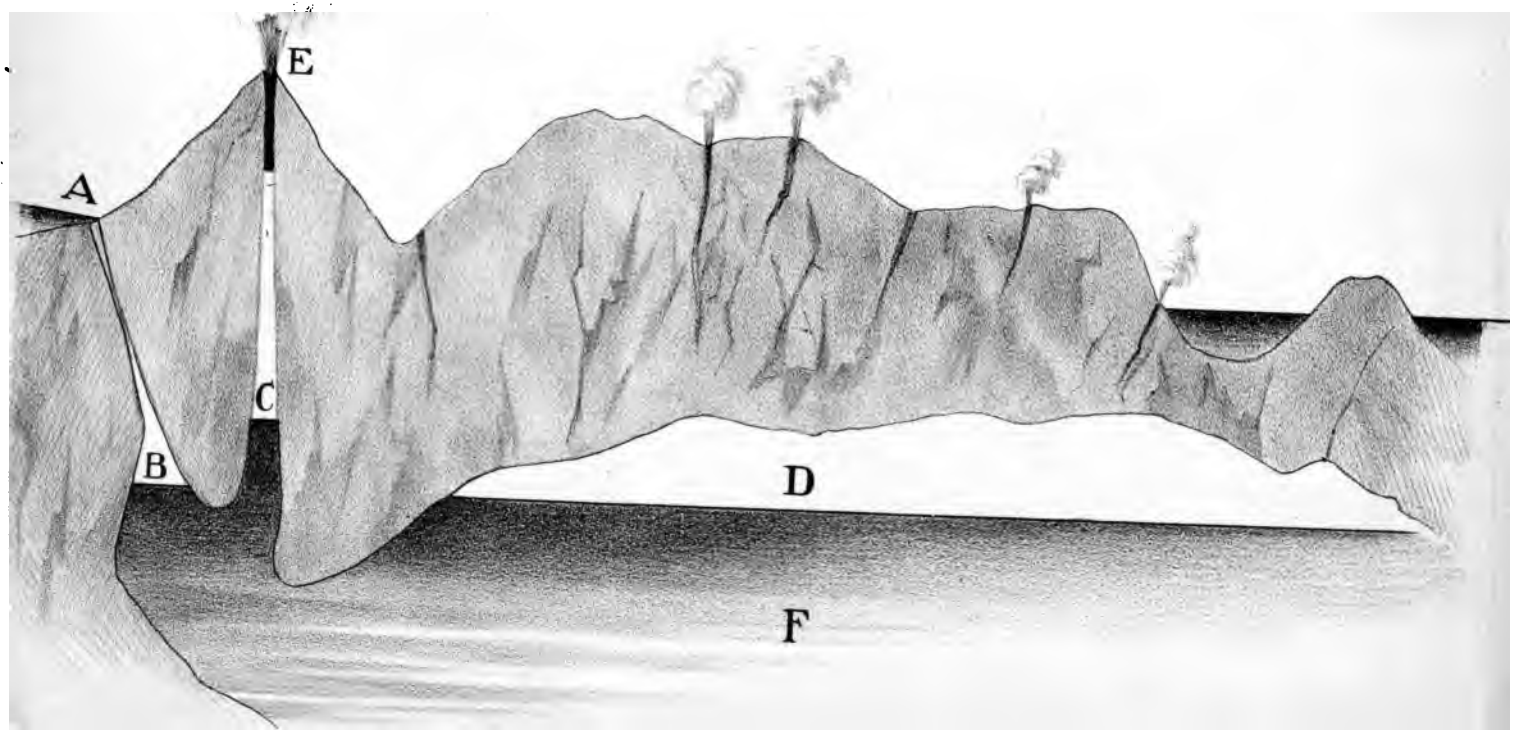

170
180
Santa Cruz Is.
(Active Volcano)
Volcano Is.
Santa Cruz.
Vani Koro
Banks Is.
Vanua Lava
(Hot Springs)
Santa Maria
Star Peak (Extinct Crater)
Aurora (Sinter Terraces Remains)
Santo
Malicolo
Pentecost
Ambrim (Active Volcano)
Lopevi (Active Volcano)
NEW HEBRIDES
Shepherd Is.
(Extinct Crater)
Efate
(Submarine Eruption)
Tamanga
Aniwa
Fotuna
NEW CALEDONIA
(Active Volcano)
Tana
Aneityum (Extinct Crater)
Loyalty Is.
Mare
Noumea
Is of Pines
Matthews Is.
(Hot Springs)
Hunter Is.
(Hot Springs)
FIJI ISLANDS
Vanua Levu
Viti Levu
Norfolk Is.
NEW ZEALAND
F.A. Campbell



Portion Marked ▨ is of recent igneous origin


Fresh Water Lake
Crevices taking Overflow from Lake
Lava bed
Mt Yasur
Sulphur Beds
Hot Clay 200°
Hot Lake 100°
Hot Springs xx 200°
Hot Springs 200° xx
Recent Upheavals
PORT RESOLUTION
xx Hot Springs 100°
Lava Bed
Hot Springs xx
Chart of Volcanic District of Tana




E
A
C
B
D
F

The phenomena connected with the violent state might be explained by the fact that a lowering of the atmospheric pressure would be followed by the rising of the column in the vent, and so giving a larger quantity of lava to be ejected. It would also be followed by an increased quantity of steam generated from the lava, which added to that formed as before in the steam chamber, would cause the eruptions to be much more rapid. This would be assisted also by additional water supply in wet weather.

The paroxysmal state may perhaps be explained by the sudden lowering of atmospheric pressure for a great distance along a volcanic fissure, the consequent formation of a large quantity of steam, which finding its way to the place of least resistance, would by its sudden exit cause a catastrophe.

In conclusion I wish to state, that one of my chief objects in submitting this paper to you is to direct attention and inquiry towards this unique and little known volcano, and also to the group in which this and other volcanoes exist; and I have to express the hope that a systematic and thorough investigation of the many interesting scientific features in the New Hebrides and surrounding islands, may be a work in which the Royal Society of Victoria may see its way to engage.

X.—*The Oceanic Languages Semitic.*

By Rev. D. Macdonald, Fate, Havannah Harbour, New Hebrides.

ART. XI.—*Notes on the Physiography of the Western portion of the County of Croajingolong.*

With two Wood-cuts.

BY JAMES STIRLING, F.G.S.

[Read Dec. 13, 1888.]

PART I.—TOPOGRAPHY.

The extreme eastern portion of the Colony of Victoria is, perhaps the least known area within its boundaries. Having recently traversed the area in several directions, from the coast line to the colony boundary, in order to examine areas being prospected for gold, the author embraced the opportunity of making, in addition to geological observations, some notes on the native vegetation or botany, and climate or meteorology of the area, which it is hoped may serve as an introductory notice of the physiography of this little known region of Victoria.

THE WATERCOURSES.

The principal valleys excavated from the area are the Snowy and its tributaries, and the Bemm and Cann rivers. The Snowy forms the western boundary of the county of Croajingolong, and has the largest drainage area. Rising outside the limits of the area, amid the snow-clad heights of Mount Kosciusko, the Pilot, and Mount Cobberas, at an elevation between 6000 and 7256 feet, the Snowy has eroded its passage through rock masses which may be said to present geotectonic features of great interest to the geologist, mainly, palæozoic rocks in the upper valley, and tertiary in the lower. The effects of the unequal ratios of denudation and erosion of different rock masses under similar and different climatal conditions, are strikingly exhibited in the Snowy watershed area; but as the main features lie outside the county of Croajingolong, partly in the county of Tambo, Victoria, and in the Maneroo table land in New South Wales, they cannot be properly discussed in this paper. In the Rev. W. B. Clarke's "Southern Gold Fields," and

A. W. Howitt's "Devonian Rocks of North Gippsland, will be found most interesting information on the eastern and western sources of the Snowy River. The enormous erosion of the middle portion of the Snowy Valley is plainly seen from Turnback Mountain on the old Maneroo road, or from the summit of Mount Tingiringy, near the New South Wales border. The landscape looking north from the latter mountain is perhaps the finest mountain scene in Australia—it is certainly one of grandeur. To the north, beyond the deep gorge formed by the Snowy River, rise a series of bold wooded mountains, the lower spurs of the latter almost invisible in the soft haze of the deeper portions of the valley. Beyond the wooded mountain ranges appear in silhouette the rugged porphyry heights of Mount Cobberas, the coned peak of Mount Pilot, and rising tier above tier the bold granite knobs of the Snowy Kosciusko plateau. Away to the right stretches the fine open and undulating downs of the Maneroo plateau, relieved here and there by minor ridges covered with timber, or along the creeks by belts of the Snowy River pine. While to the south the bold outlines of Mount Delegate, Mount Bowen, and the coast range, mark the sites of rock masses which have longest resisted the effects of subaerial denudation and the borderland between the jungle country of Croajingolong and the south-western extension of the Maneroo table land.

As the Snowy drains the highest elevations in Australia, and runs almost due south from their high altitudes to the coast line, its course is almost torrential throughout, except where it enters the rich alluvial flats of Orbost, where the stream becomes sluggish. To enter into a minute description of the salient points in the topography of the eastern watershed area, would form the subject matter for an interesting paper, so varied is the surface configuration. The principal eastern source affluents drain the extensive Maneroo plateau outside the boundary of the colony, and need not be referred to. The streams within the county comprise the Deddick or Jingallala and its tributaries, the Tingiringy, Dellicknora, Cabanandra, and Bonang. There are several others which, ultimately flowing into the parent stream in New South Wales, rise in the coast range, such as the Delegate, Bendoc, Queensborough. Below the junction of the Deddick, several torrential streams enter the Snowy from the east, their courses mainly south-westerly, such as Mountain Creek, the Broadbent, Yalma, and Rodgers Rivers. Below the Orbost

flats, and near its estuary, the most important tributary the Broadribb and its affluent, the Cabbage-tree Creek, enter the parent stream. Rising in the coast range at Bonang Mountain, and running parallel with the Snowy, the Broadribb drains the western slopes of the highest points in the county, viz., Mount Ellery and the M'Culloch ranges. With the exception of some moderate extent of flats and undulatory slopes at Goonegerah in the upper portion of the valley, and the flats and morasses near its junction with the Snowy, this river intersects rangy territory of very little use for cultivation, while the tributaries are covered with dense jungle. In the heads of the Cabbage-tree Creek, St. Patrick's Creek, and other eastern affluents draining the M'Culloch ranges, is a very rich vegetable mould and soil, which may hereafter repay cultivation, although the cost of clearing would necessarily be considerable. The flats and spurs towards the coast regions are already occupied by an enterprising body of selectors, who are fast reclaiming the morass and forest lands in the vicinity.

The streams which flow southerly through the central portion of the county comprise the Bemm and Cann, with two other unimportant minor streams, the Little River and Yeerung. The Cann forms the eastern boundary of the area under consideration, and has the largest area of land available for settlement. To the north of Morgan's station, on the road to Genoa, a considerable area of flats and undulatory ranges has been selected, and west of Mount Kate there is a limited area of well grassed pasture lands awaiting settlement, and on the upper portion of the valley, as at Buldah, are other limited areas.

In the Bemm valley, as at Combinebar Creek, are rolling well grassed hills, and some rich but densely timbered flats, while several of the western affluents, as the Glen Arte River and portions of the McKenzie, present favourable areas for future settlement, although the dense jungle in the gullies and the large trees in the flats will make clearing expensive.

In the Yeerung valley towards the coast, and also in the Cabbage-tree Creek, are open heath lands which may be converted into pasture lands, especially in places where there is a coating of black, vegetable mould and clayey material overlying the sandy deposits. The area in which the cabbage palm *(Livistona Australis)* flourishes has been reserved from destruction.

The Ranges and Mountains.

The main features of the mountain system is indicated by the courses of the principal streams. The principal watershed line is the coast range intersecting the northern portion of the county in an easterly direction and lateral ridges running southerly towards the coast from this main watershed line. The highest points on the coast range are Mount Bowen at the head of Mountain Creek, Mount Goonmurk, 4300ft., at the head of the Bemm, and Mount Tennyson on the Colony boundary towards the head of the Cann river.

The most prominent peak in the county is perhaps Mount Ellery, on the ridge dividing the Broadribb and Bemm. Viewed from the coast, the southward extension of this watershed line, the McCulloch Ranges are next in importance, while near the coast, on the ridge dividing the Broadribb and Cabbage-tree Creek, rises a rounded peak, Mount Raymond. The highest point on the divide between the Bemm and the Cann is perhaps Mount Bengow (near the Coast Range), while towards the south, nearer the coast, Mount Cann is a prominent landmark. On the eastern watershed of the Cann, Mount Kate stands high above the surrounding ranges.

The higher points on the north of the Coast Range—Mount Goolinbabylon, between the Bonang and Delegate Rivers; Mount Delegate, between the Bendoc and Delegate Rivers; and Mount Tingiringy, near the Colony boundary, between the Jingallala and Mount Richie Creek.

Meteorology.

In looking at these mountains as a whole, and after examining the character of their rocky structure, viz., hard silicious rocks, quartzites, and indurated slates, granites, &c., the conviction is forced on the observer that they are formed by sub-aerial denudation, having longest resisted the degrading influences of the rain, frost, and snow, while the surrounding softer materials have been removed.

The difference in the amount of excavation exhibited by the south-flowing streams and those flowing northerly may, I think, be ascribed to greater precipitation of rainfall on the southern slopes, the combined influence of the south-west and south-easterly moisture-laden winds, an extension of the

warm tropical rains coming from the east north-east along the eastern Australian coast reaching the area.

In the Bendoc district, at an elevation of 2500 feet, severe frosts are not uncommon, and the range of temperature is frequently great. The snow falls annually over this area, but in the upper valleys of the Broadribb, Bemm, and Cann humidity prevails, and the temperature is more equable, frosts being far less frequent. This difference in the hygrometric and thermometric conditions produces the differences observed in the vegetation at similar elevations north and south of the coast range. And this is again very marked as the coast line is reached, so that the meteorologic conditions affect the vegetation directly. And the latter are mainly due to the varied surface configuration, resulting from the unequal decay of the different rock masses.

BOTANY.

Notes on the Vegetation (Peculiar Features).

The most striking feature in the vegetation of the areas examined in Croajingolong is the presence of many East Australian types not found elsewhere in Victoria, and in the luxuriance of the climbing plants. The arboreous form of the Waratah (Telopea oreades) with its magnificent clusters of rich carmine-tinted flowers on terminal spikelets, surrounded by glossy sap-green leaves, at once arrests the attention of the botanical observer. Flowering during October and early in November it attains in the rich humid valleys surrounding the M'Culloch Ranges, the heads of Cabbage-tree Creek, and in the upper portions of the Bemm valley – along the coast range, &c., a height of between 40 and 50 feet.

Next to the Waratah, the profusely flowering native climbing pea (Kennedya rubicunda) is, with its brick-red blossoms, one of the most striking features, and is widely distributed over the area. In localities where it flourishes along with the native virgin's bower (Clematis aristata) and the native sarsaparilla (Kennedya monophylla), the contrasts of red, white, and blue, are most charming. Although in those places where it is interwoven with the wire grass (Ehrharta stipoides), it is the *bête noire* of the prospector or explorer. Even the dreaded thorns of the climbing lawyer (Smilax Australis) are less objection-

able than the finely serrated stems and leaves of the latter, *i.e.*, the wire grass. On the eastern tributaries of the Snowy River and in the Bemm valley, the most prolific undergrowth is that of Haloragis tetragyna or fire weed, which forms here a most useless herb, supplanting the native grasses with the exception of the scented grass—Hierochloa rariflora (a comparatively useless grass for fodder purposes, and which flourishes along with the fire weed or Haloragis tetragyna). The occurrence of the cabbage palm, Livistona Australis, on Cabbage-tree Creek, near Orbost, where it grows to a height of over 100 feet, is also a remarkable feature in the vegetation of the area. The isolation of this species from its tropical home in a humid valley in the temperate zone, require further elucidation at the hands of botanists, or of those interested in the geographical distribution of plants. I am inclined to consider it as a survival of a once tropic vegetation which covered South Eastern Australia in earlier Pliocene times, and which was destroyed by the subsequent glacial action of which there are not wanting evidences in South Eastern Australia since Miocene times.

Numerical Proportion of the Orders.

There does not appear to be any exception to the general rule respecting the orders richest in species and genera from what prevails generally over South-Eastern Australia, except that there is a closer alliance with the flora of Southern New South Wales than with the southern and western portions of Victoria. Here, as elsewhere, the grand order—Leguminosæ, and the sub-orders—Papilionaceæ and Mimoseæ, are richest in species and genera. Comparing the different orders, we find that comprised within the list are thirty species of Leguminous plants represented by fourteen genera, that the genera richest in species are Acaciæ and Pulteneæ. Of Myrtaceæ there are twenty-nine species and nine genera, the genus Eucalyptus being richest in species. Among Compositæ there are twenty-five species and twelve genera, the Helichrysa being most abundant. Among Proteaceæ the Persoonias are richest in species. This interesting order is represented by fifteen species and seven genera. The Filices or fern-family has twenty-one species and eleven genera, the Orchids twelve species and eight genera, and the Lillies or Liliaceæ eight species and seven genera, while the Gramineæ or grasses include nine genera and species.

Distribution of Species.

The area under examination may be said to comprise four well-marked regions, each broadly characterised by the presence of certain species of plants which impart a distinct physiognomy to the situations wherein they flourish.

If a line is drawn parallel to the coast line at a distance of 6 miles, it will be found that up to an elevation of 300 feet above sea level the vegetation differs from that found in the gullies and valleys further inland up to the flanks of the coast range to, say 4000 feet elevation; that the crests of the ridges within the middle area contain species not found in the gullies; and that in the more open table land north of the coast range there are abundance of sub-alpine species not found in any of the other areas or situations.

The Coastal Regions.

Along the sand hammocks, Salsolaceæ and Ficoideæ prevail —Rhagodia, Chenopodium, Atriplex, and Mesembrianthemum (or pig's face); and in the hollows, such Myrtaceous shrubs as Melaleuca armillaris, Kunzea corifolia, Leptospermum myrsinoides; and grasses, as Zoysia pungens. In the open undulating coastlands, between belts of Eucalyptus, including the mahogany E. botryoides and abundance of Banksia serrata, are grass-tree flats with Xanthorrea Australis, and X. minor—the dwarfed sheoak, Casuarina paludosa, in the undulating sand hills, where the timber vegetation is more prolific, an abundance of Caustis flexuosa and Lycopodium densum, Ricinocarpus pinifolius, and other shrubby and herbaceous species, together with a great number of species less peculiar to the coastal areas as Epacris impressa, Hibbertias, Styphelias. To enumerate them would extend this paper to an unusual length.

Inland Region.—Gullies and River Flats.

The most arboreous vegetation is found in the moist gullies and on the river flats, and with the exception of the hollows or lowest points in the ridges yields characteristic forms, differing from those on the ridges. Among many such arboreous forms may be mentioned the Waratah (Telopea oreades), the native musk (Aster argophyllus), Lillypillies,

(Eugenia Smithii), native pepper tree (Drimys aromatica), the native sassafras (Atherosperma moschatum), native firewood (Hedycarya Cunninghami), Pittosporum undulatum, P. bicolor, Zieria Smithii, Acacia decurrens, A. melanoxylon, Eucalyptus amygdalina, E. pilularis, E. longifolia, and others; Prostanthera lasiantha, Lomatia ilicifolia, Sambucus Gaudichaudiana; and such creepers as Lyonsia stramina, Smilax Australis, Vitis hypoglauca, &c., and Sarcopetalum Harveyanum, Rubus rosifolius.

Ridges.

On the heads of gullies and lower points of the ridges—Eriostemon trachyphyllus, Senecio Bedfordii, Correa Lawrenciana, Dodoneas, Oxylobium ellipticum, Hovea longifolia, Indigofera Australis, Goodia lotifolia, and several Acacias, Eucalypts, Pomaderris, Panax, Persoonia, Lomatia longifolia, Pimelea, Coprosma hirtella, Asters, Notelea lanceolata, Solanum, Helichrysum obcordatum, Cassinia aculeata, Helichrysum cuneifolium, and others.

The Sub-Alpine or Table-land Areas.

Here in the open grassy valleys and woodlands are found, between 2500 and 4000 feet, numerous species, which extend over large areas in the Australian Alps, patches of Stellaria pungens, fine undershrubs, as Oxylobium procumbens, Mirbelia, Pulteneas, Persoonia Chamaepeuce, Hakea microcarpa, Pimelia ligustrina, Brachycomes, Aster megalophyllus, Lagenophora Billardieri; Helichrysums, as H. apiculatum, H. semipapposum, Gnaphalium Traversii, Gentiana saxosa, Euphrasia Brownii, Ajuga Australis, Styphelia Macraei, Epacris microphylla; Diplarrhena Moraea, and many others Around Bonang the latter attains its richest luxuriance at an elevation of 2000 feet, although it also flourishes in the river flats towards the coast line as at Goonegerah and Cann.

Territorial Range of Species.

Here, as elsewhere, the gum trees have the greatest territorial range, and magnificent forests of splendid splitting timber exists, notably on the flanks of the McCulloch Range

in the Broadribb and Bemm watersheds, and along the south side of the coast range in the heads of the Bemm and Cann rivers. While it is patent, that many of the giant gums exceed a height of 350 feet, I have not yet observed any over 400 feet; if there are any exceeding the latter length, it is probably in the Arte, Goolingook, or Cabbage-tree Creek valleys that they will be met with. The tallest trees are not always those with the greatest diameter of trunk. I have certainly measured trunks fully 40 feet in circumference, but as a rule the taller trees measured had a lesser circumference of from 20 to 30 feet. Next to the Eucalypts the Acacias have the greatest range, and after these the Daviesias, Haloragis tetragyna, Comesperma ericinum, and Kennedya rubicunda, together with the wire-grass.

The Evolution of Varietal Forms.

Between the summits of the higher peaks, Mount Ellery, Mount Kate, Mount Goonmurk, on the Coast Range, Mount Tingiringy north of it and the coast line, there are considerable variations in the hygrometric and other meteorologic conditions, which I believe so powerfully affect the evolution of varietal forms. I have elsewhere* endeavoured to point out as regards the Alpine and sub-Alpine florula of South-East Australia that under the slowly changing surface configuration, due to prolonged sub-aerial denudation and erosion, the transfer of soils, abraded and decomposed from the great rock masses, and the action of their chemical constituents on plant, food, &c., gradually modifying its environment, may eventually result in the differentiation of the varieties as to assume characters so distinct and apparently constant as to justify the appelation of species. Among many species which present differential characters over large areas in different habitats, I would mention Craspedia Richea, Daviesea latifolia; some Helichrysa, especially Helichrysum rosmarinifolium; some Rutaceæ, Drimys aromatica, Hymenanthera Banksii, Claytonia Australasica, Panax sambucifolius, Gentiana saxosa, Styphelia ericoides, and Microseris Forsteri.

* On the Physiography of the Australian Alps. Transactions of Australian Association for Advancement of Science, 1888.

LIST OF SPECIES OF PLANTS COLLECTED IN THE AREA, AND ARRANGED ACCORDING TO BARON VON MUELLER'S CLASSIFICATORY SYSTEM, "SYSTEMATIC CENSUS OF AUSTRALIAN PLANTS."

Ranunculaceæ (A. L. de Juss.)

Ranunculus aquatilis (Dod.) Orbost.
„ lappaceus (Sm.) Orbost and Bendoc.
„ rivularis (Bks.) Orbost.
Clematis aristata (R. Br.) Orbost, Broadribb, & Coast Range.

Dilleniaceæ (Salsb.)

Hibbertia Billardieri (F. v. M.) Cann River.
„ dentata (R. Br.) Goolingook River.

Magnoliaceæ (J. de St. Hil.)

Drimys aromatica (F. v. M.)
Coast Range and Goolingook Valley; tree 20 to 30 ft. high.

Menispermeæ.

Stephania hernandifolia (Walp.) Cann Valley.
Sarcopetalum Harveyanum (F. v. M.) Lower Snowy River.

Monimieæ (A. L. de Juss.)

Atherosperma moschatum (Labill.)
Forms dense forests along Coast Range; at Mt. Goonmurk, trees are 120 feet to 150 feet high, with trunks 6 feet in diameter.
Hedycaria Cunninghami (Tulasne).
Mt. Goolinbabylon and Coast Range.

Lauraceæ (Vent.)

Cassytha pubescens (R. Br.) Upper Cann Valley.
„ melantha (R. Br.) Broadribb and Orbost.

Cruciferæ (A. L. de Juss.)

Cardamine hirsuta (Linn.) Bendoc.

Violaceæ (De Cand.)

Viola hederacea (Labill.) Orbost.
„ Caleyana (Don.) Bendoc and Orbost.
Hymenanthera Banksii (F. v. M.) Broadribb and Cann.

Pittosporeæ (R. Br.)

Pittosporum undulatum (Andr.)
Snowy, Broadribb, Bemm, and Cann Rivers, near Coast.

Pittosporum revolutum (Aitn.) Cann Valley.
„ bicolor (Hook.)
Bursaria spinosa (Cav.) Broadribb and Cann.
Marianthus procumbens (Benth.) Broadribb and Orbost.
Billardiera scandens (Smt.) Cann and Orbost.

Droseraceæ (Sals.)

Drosera auriculata (Bach.) Orbost and Cann.

Polygaleæ (A. L. de Juss.)

Comesperma ericinum (De Cand.) Orbost and Benn.
„ volubile (Labill.)
Orbost, Broadribb, Cann and Bemm Valleys.
Very aromatic, like true sarsaparilla root, and can be used as an alterative.
Comesperma defoliatum (F. v. M.) Broadribb River.

Tremandreæ (R. Br.)

Tetratheca ciliata (Linn.)
Very abundant on eastern tributaries of Snowy River.

Rutaceæ (A. L. de Juss.)

Zieria Smithii (Andr.) Coast Range, Cann, & Bemm Valleys.
Eriostemon trachyphyllus (F. v. M.)
Upper Bonang and Broadribb Valleys.
Correa Lawrenciana (Hook.) M'Culloch Ranges, Bonang.
„ speciosa (Andr.) Coast region.

Lineæ (De Cand.)

Linum marginale (Cunn.) Orbost.

Geraniaceæ (A. L. de Juss.)

Pelargonium Australe (Willd.) Coast region.

Malvaceæ (Adanson).

Howittia trilocularis (F. v. M.) Orbost.

Sterculiaceæ (Vent.)

Brachychiton populneum (R. Br.) Broadbent River.
Commersonia Frazeri (J. Gay) Cann Valley.
Lasiopetalum dasyphyllum (Sieb.)
Coast Range, Broadribb Valley.

Tiliaceæ (A. L. de Juss.)

Elæocarpus holopetalus (F. v. M.)
Broadribb, Bemm, Cann, Bonang, and Mt. Goonmurk.

Euphorbiaceæ (A. L. de Juss.)

Micrantheum hexandrum (Hook.)	Cann Valley.
Ricinocarpus pinifolius (Desfont).	Broadribb, near Coast.
Bertya Cunninghamii (Planch.)	Snowy River.
Amperea spartioides (Brong.)	Broadribb River.
Phyllanthus thymoides (Sieb.)	Cann and Bemm Rivers.
,, Gunnii (Hook.)	Broadribb.
Adriana acerifolia—tomentosa—(Hook.)	Snowy River.

Casuarineæ (Mirb.)

Casuarina paludosa.	Marlow.
,, distyla (Vent.)	Orbost.

Viniferæ (I. de St. Hil.)

Vitis hypoglauca (F. v. M.)
Broadribb, Bemm, and Cann Valleys.

Sapindaceæ (A. L. de Juss.)

Dodonæa viscosa (Linn.) Broadribb.

Stackhousieæ (R. Br.)

Stackhousia linarifolia (Cunn.) Orbost.

Portulaceæ (A. L. de Juss.)

Claytonia Australasica (Hook.) Bendoc.

Caryophylleæ (Linn.)

Stellaria pungens (Brong.)	Bendoc.
,, flaccida (Hook.)	Bemm and Cann Valleys.

Salsolaceæ (Linn.)

Rhagodia Billardieri (R. Br.)	Coast Region.
Chenopodium murale (Linn.)	Cann, towards Coast.
,, glaucum (Linn.)	Coast Region.
Atriplex crystallinum (Hook.)	Coast, Snowy River.

Ficoideæ (A. L. de Juss.)

Mesembrianthemum æquilaterale (Haw.) Sand Hammocks.

Polygonaceæ (A. L. de Juss.)

Mühlenbeckia axillaris (Hook.) Snowy River.

Leguminoseæ, sub order *Papilionaceæ.*

Oxylobium ellipticum (R. Br.)
Glen Arte River, Coast Range.

Oxylobium procumbens (F. v. M.)	Mt. Tingiringy.
Mirbelia oxyloboides (F. v. M.)	Near Bendoc.
Gompholobium Huegelii (Benth.)	Delegate & Bonang Rivers.
Daviesia latifolia (R. Br.)	Orbost.
,, ulicina (Sm.)	Delegate River.
Aotus villosa (Sm.)	Broadribb.
Pultenea daphnoides (Wend.)	Bemm Valley.
,, retusa (Sm.)	Broadribb.
,, juniperina (Labill.)	Bonang.
,, fasiculata (Benth.)	Cann Valley.
Platylobium obtusangulum (Hook.)	Orbost.
Bossiæa buxifolia (Cunn.)	Cann Valley.
,, microphylla (Sm.)	Orbost.
Hovea longifolia (R. Br.)	Broadribb.
Goodia lotifolia (Sals.)	Broadribb, Bemm, and Cann Valleys.
Indigofera Australis (Willd.)	Goolingook, Bonang River.
Glycine clandestina (Wend.)	Orbost and Broadribb.
Kennedya rubicunda (Vent.)	All over Middle of County.
,, monophylla (Vent.)	Orbost, Bonang, &c.

Sub order, *Mimoseæ.*

Acacia juniperina (Willd.)	Cann Valley.
,, vomeriformis (Cunn.)	Cann.
,, stricta (Willd.)	Cann.
,, penninervis (Sieb.)	Cann and Snowy.
,, pycnantha (Benth.)	Broadribb Valley.
,, myrtifolia (Willd.)	Cann Valley.
,, linearis (Sims).	,,
,, melanoxylon (R. Br.)	Broadribb, Bemm, and Cann.
,, longifolia (Willd.)	Cann Valley.
,, decurrens (Willd.)	Cann, Bemm, and Broadribb.

Rosaceæ (A. L. de Juss.)

Rubus parvifolius (Linn.)	Orbost.
,, rosifolius (Sin.)	Orbost, near Marlow.

Saxifrageæ (Vent.)

Bauera rubiodes (Andr.)
All over the Bemm Valley and around Orbost.

Crassulaceæ (De Cand.)

Tillea verticlilaris (De Cand.) Orbost.

Onagreæ.

Epilobium tetragonum (Linn.) Bendoc and Snowy River.

Thymeleæ.

Pimelea ligustrina (Labill.)
Mount Goonmurk and Coast Range.
„ axiflora (F. v. M.) Bendoc River.
„ sp. Orbost.

Rubiaceæ.

Coprosma Billardieri (Hook.) Cann and Orbost.
„ hirtella (Labill.) Bonang.
Morinda jasminoides (A. Cunn.) Broadribb and Snowy.

Compositæ.

Brachycome decipiens (Hook.) Bonang and Orbost.
Aster megalophyllus (F. v. M.) Delegate River.
„ argophyllus (Labill.)
Coast Range and streams flowing South.
„ stellulatus (Labill.) Bemm Valley.
(Var. quercifolia.)
„ iodochrous (F. v. M.) Snowy River, Orbost, Cann, &c.
Calotis lappulacea (Benth.) Snowy River and Orbost.
Lagenophora Billardieri (Cass.) Bendoc.
Podolepis acuminata (R. Br.) Bendoc.
Helipterum anthemoides (De Cand.) Mount Delegate.
Helichrysum scorpioides (Labill.) Bonang.
„ bracteatum (Willd.) Coast Range.
„ leucopsidium (De Cand.) Broadribb.
„ apiculatum (De Cand.) Bendoc and Orbost.
„ semipapposum (De Cand.) Bendoc and Bonang.
„ rosmarinifolium (Less.) Delegate River.
(Var. thyrisoides.)
„ obcordatum (F. v. M.) Mount Buck.
„ cuneifolium. „
Cassinia aculeata (R. Br.) Bonang and Delegate Rivers.
Humea elegans (Sm.) Broadribb.
Gnaphalium Traversii (Hook.) Craigie Bog.
Craspedia Richea (Cass.) Bendoc and Orbost.
Senecio spathulatus (A. Rich.) Orbost.
„ lautus (Sol.) Bemm Valley.
„ Australis (A. Rich.) Snowy River.
„ Bedfordii (F. v. M.)
Broadribb, Bemm and Cann, Coast Range, Bonang.

Caprifoliaceæ.

Sambucus Gaudichaudiana (De Cand.) Orbost.

Campanulaceæ (A. L. de Juss.)

Lobelia purpurascens (R. Br.)	Snowy River.
Wahlenbergia gracilis (A. de Cand.)	Orbost.

Candolleaceæ (R. Br.)

Stylidium graminifolia (Swartz.)	Orbost.

Goodeniaceæ (R. Br.)

Goodenia paniculata (Sm.)	Snowy River.
Scævola hispida (Cav.)	Broadribb and Bemm.
Dampiera stricta (R. Br.)	Goolingook Ranges and Orbost.

Gentianeæ (B. de Juss.)

Limnanthemum crenatum (F. v. M.)	Delegate River.
Gentiana saxosa (Forst).	Mount Goonmurk.

Primulaceæ (Vent.)

Samolus Valerandi (Linn.)	Orbost.

Myrsinaceæ (R. Br.)

Myrsine variabilis (R. Br.)
Snowy, Broadribb, Bemm, and Cann Rivers.

Jasmineæ (A. L. de Juss.)

Notelæa lanceolata (Vent.)	Sardine Creek Ridges.

Apocyneæ (A. L. de Juss.)

Lyonsia straminea (R. Br.)	Bonang, Broadribb.

Asclepiadeæ (Jacq.)

Tylophora barbata (R. Br.)	Snowy River.
Marsdenia rostrata (R. Br.)	Broadribb.

Convolvulaceæ (A. L. de Juss.)

Convolvulus erubescens (Sims).	Orbost, Bonang.
„ marginatus (Poir.)	Broadribb & Snowy Rivers.

Solanaceæ (Hall.)

Solanum vescum (F. v. M.)	Bonang, Orbost.
„ aviculare (Forst.)	Snowy River.
„ pungetium (R. Br.)	Broadribb River.

Scrophularinæ (Mirb.)

Gratiola Peruviana (Linn.)	Snowy and Bonang Rivers.
Veronica Derwentia (Andr.)	Orbost.
„ perfoliata (R. Br.)	Bonang and Delegate.
Euphrasia Brownii (F. v. M.)	Bendoc.

Labiatæ (Adanson).

Mentha laxiflora (Benth.)	Snowy River.
Plectranthus parviflorus (Willd.)	Broadribb and Snowy.
Salvia plebeja (R. Br.)	Broadribb and Snowy.
Prostanthera lasiantha (Labill.)	Coast Range, Bonang.
Teucrium corymbosum (R. Br.)	Upper Bemm Valley.
Ajuga Australis (R. Br.)	Orbost and Bonang.

Myoporinæ (R. Br.)

Myoporum floribundum (Cunn.)	Orbost and Bonang.

Epacrideæ (R. Br.)

Styphelia lanceolata (Sm.)	Cann River.
„ Macraei (F. v. M.)	Cann and Upper Bemm.
Epacris impressa (Labill.)	Marlow.
„ microphylla (R. Br.)	Bendoc.

Orchideæ (Hall.)

Dipodium punctatum (R. Br.)	Broadribb Valley.
Spiranthes Australis (Linn.)	Broadribb Valley, Snowy River.
Thelymitra ericoides (Sm.)	Snowy River.
„ longifolia (Forst.)	Orbost
Diuris punctata (Sm.)	„
„ pedunculata (R. Br.)	„
„ longifolia (R. Br.)	Cann.
Cryptostylis longifolia (R. Br.)	Orbost.
Pterostylis nutans (R. Br.)	„
Caladenia Patersoni (R. Br.)	Cann.
„ carnea (R. Br.)	Bonang.
Glossodia minor (R. Br.)	Cann and Bemm.

Irideæ (Vent.)

Diplarrhena Moraea (Labill.)	Broadribb, Bonang, Orbost, and Snowy Rivers.
Patersonia glabrata (R. Br.)	Snowy River, Marlow.
Sisyrinchium paniculatum (R. Br.)	„ „

Liliaceæ (Hall.)

Smilax Australis (R. Br.)	Bonang and Snowy Rivers.
Rhipogonum album (R. Br.)	Snowy River.
Eustrephus latifolius (R. Br.)	,,
Thysanotus tuberosus (R. Br.)	Cann and Broadribb.
Stypandra glauca (R. Br.)	Orbost.
Xerotes longifolia (R. Br.)	Goonegerah and Marlow.
Xanthorrhœa minor (R. Br.)	Coast Regions.
,, Australis (R. Br.)	,,

Palmæ (Ray).

Livistona Australis (Mart.)	Cabbage Tree Creek.

Typhaceæ (A. L. de Juss.)

Typha angustifolia (Linn.)	Snowy River.

Junceæ (R. Br.)

Luzula campestris (De Cand.)	Orbost.

Restiaceæ (R. Br.)

Centrolepis strigosa (Roe).	Snowy River.
Leptocarpus Brownii (Hook.)	,,

Cyperaceæ (Hall.)

Cyperus lucidus (R. Br.)	Orbost.
Schœnus axillaris (Poir.)	,,
Caustis flexuosa (R. Br.)	Coast Region, Cann.

Gramineæ (Hall.)

Panicum marginatum (R. Br.)	Snowy River.
Oplismenus compositus (Pal.)	Broadribb.
Zoysia pungens (Willd.)	Coast Region.
Anthistiria ciliata (Linn.)	Broadribb.
Hierochloa rariflora (Hook.) (Scented grass.)	All over the Broadribb, Snowy, Cann, Bemm, and Bonang Valleys.
Pappophorum commune (F. v. M.)	Snowy River.
Poa cæspitosa (Forst).	Broadribb Valley.
Agropyron pectinatum (Pal.)	Snowy River.
Erharta stipoides (Labill.) (Wire grass.)	All over the area.

Lycopodineæ (Swartz.)

Phylloglossum Drummondii (Kunze)	Cann.
Lycopodium clavatum (Linn.)	Snowy River.
„ densum (Labill.)	Cann River.

Filices (Linn.)

Gleichenia circinata (Swartz.)	Bonang.
„ flabellata (R. Br.)	Yalma River.
Todea Africana.	Broadribb, Bonang.
Dicksonia antarctica (Labill.)	McCulloch Ranges, Broadribb, Cann, Bemm.
Adiantum Aethiopicum (Linn.)	Orbost.
Adiantum formosum (R. Br.)	Broadribb and Snowy.
Pteris falcata (R. Br.)	Bemm, Cann, and Broadribb
„ tremula (R. Br.)	Snowy River.
„ aquilina (Linn.)	„
Lomaria discolor (Willd.)	Orbost, Bonang, Bemm, and Broadribb.
„ capensis (Willd.)	Bonang, Mt. Goonmurk.
Blechnum cartilagineum (Swartz.)	Broadribb and Cabbage Tree Creek.
Doodia aspera (Mett.)	Broadribb and Snowy Rivers.
Asplenium trichomanes (Linn.)	Rodgers River.
„ flabellifolium (Cav.)	Bendoc.
„ bulbiferum (Forst.)	Bonang.
„ umbrosum (J. Sm.)	Snowy and Broadribb.
Aspidium aculeatum (Swartz.)	Snowy River.
„ decompositum (Spreng.)	„
Polypodium punctatum (Thun.)	Broadribb and Snowy.
„ serpens (Forst.)	Cabbage Tree Creek, Broadribb, Orbost.

The Geological Structure.

The rocks of the western portion of Croajingolong do not present many peculiar features. In the upper portion of the area, silurian slates and sandstones prevail; in the middle, a belt of granite stretches across from east to west; and towards the coast, are pliocene bouldery deposits overlying occasional outliers of partially denuded miocene gravels, clays, and limestone bands.

Infolded with the Silurian are occasional outliers of conglomerate shales and limestone bands, and some patches of tertiary basalt. Towards the Cann Valley are masses of

brown and red sandstones and conglomerates, and grits apparently Devonian; while still further eastward towards the colony boundary are some yellow sandstones and grits bearing a striking resemblance to the lower members of the N.S.W. carboniferous series. The localities where each group of rock formations are found may be best described by taking each group according to stratigraphical succession.

Sedimentary Rocks.

Lower Silurian.

The oldest sediments observed are the black slates of the eastern tributaries of the Snowy, as at Deddick and at the Yalma, where graptolites occur. These black slates are vertical and finely laminar, and are evidently lower Silurian. So far as known at present, these black graptolitic slates do not extend further to the eastward. At Bonang they are replaced by ash-coloured and brownish shales and grey quartzites, and at Bendock by fawn-coloured, pinkish, and yellowish slates, shales, and fine-grained felsitic sandstones with a lesser angle of dip by from 50° to 80°. In the Broadribb Valley, the sediments are more indurated, and have suffered much contortion, as seen on the range dividing the Broadribb and Sardine Creeks, northerly from Mount Buck, where they consist of brown, indurated sandstones, and flexured hard slates full of quartz segregations. On the Black Watch Creek and Goolingook the slates are blue and more persistent in strike, with interlaminated bands of grey close-grained quartzite. The former resemble upper Silurian sediments, while the latter the lower. No line of demarcation has yet been found within the area. The lithological characters and angle of dip are not sufficient to determine a stratigraphical horizon. The induration of much of the sedimentary masses is evidently due to the intrusion of granite masses either as bosses *in situ* or ramifying dykes of hornblende (diorite) rock associated with the intrusive masses.

Upper Silurian.

On the range dividing the Broadribb and Snowy Rivers at the head of Sardine Creek (northern branch) is a band of greyish and whitish marble and masses of coarse conglomerates and jointed shales. The marble band yields some stems of Actinocrinus of apparently upper Silurian facies. The con-

glomerates are lithologically similar to certain beds lying at the base of the middle Devonian elsewhere, as at Bendi ;* and also to some outliers at Giblo River† They may, I think, be provisionally classed as upper Silurian.

Devonian.

On the divide between the Bemm and Cann, the eastern watershed of the Combinebar Creek, and at Buldah, are masses of quartzose conglomerate and red sandstones, presenting in places a low angle of dip 30° to 60°, presenting similar features to the Devonian sandstones and conglomerates of Mount Tambo.‡ They are certainly stratigraphically superior to the slates and sandstones of the Yalma and Bendoc, and may be provisionally classed as Devonian. Like the former, they have been subjected to the indurating effects of adjacent granite masses occupying the lower part of the Cann valley. The sandstones being converted into quartzites, and the conglomerates into porphyries or porphyritic conglomerate, I cannot assign any age to these masses ; they may represent upper Devonian. All that can be safely said in the absence of fossils is, that they are younger than any members of the upper Silurian, and are overlaid further to the east by what appears to be an outlier of carboniferous sandstone. The latter will be referred to in a subsequent paper on the "Physiography of the Eastern Portion of the County of Croajingolong," for which I am preparing data.

PLUTONIC.

From the Cabanandara valley, and also at Bonang and the Delegate River north of the coast range, a mass of granite stretches through the centre of the county to the Cann River at Morgan's homestead—Mount Ellery is the centre of this broad band of granite. A huge tor, occupying the highest point of the mountain, forms a prominent feature in the landscape. From the induration and metamorphism which this plutonic mass has effected along its margin, it is younger than any of the palæozoic sediments. At Bonang it is a ternary compound of glassy quartz, white and greyish

* Notes on the Physiography of the Tambo Valley. J. Stirling, in Transactions Geological Society of Australasia, 1887.

† Notes on the Giblo River Tableland. J. Stirling, in Mining Reports for September, 1887.

‡ On the Devonian Rocks of North Gippsland. By A. W. Howitt, F.G.S. Government Report Geological Survey of Victoria.

orthoclase felspar, and greenish mica. The upper portion of the mass has a gneissose appearance, as if the mass had been subject to lateral strain and crushing, causing re-arrangements of the constituents subsequent to its original solidification from a plastic molten mass.

To the south as at Sardine Creek, on the Broadribb, the middle portion of the Erinundra, on the Bemm, the heads of Tongii Creek, and on the Cann at Morgan's, it has accessory hornblende in places, is in fact syenitic. The age of these granitic masses is probably Devonian: they form part of the plutonic masses which invaded the Palæozoic sediments at the close of the Devonian period, and exposed by subsequent denudation.

At the Yeerung River are masses of quartz, porphyry, and felsites, also probably part of the later Devonian volcanic activities. So far as known at present, the Mesozoic series are absent.

Tertiary.—Miocene.

The next defined group of rocks are the yellow limestone bands resting on the denuded surfaces of the Silurian or granite rocks, and overlaid by bouldery wash clays, gravels, and sand deposits. This formation is found near the coast, well exposed cliffs are seen on the west side of the Snowy near Orbost, and occasional remnants are met with on the east side, yielding characteristic fossils.

At Bonang, and in certain places along the western watershed of the Broadribb River, are outliers of tertiary basalt which appear to have filled the Miocene River valleys although the surrounding hills have been degraded. At Bonang, underlying the basalt there and on the western rim, are outcrops of what at first would be considered a heavy river bouldery deposit. Further close examinations suggested to me that it was in reality a remnant of a Devonian conglomerate (some of the waterworn boulders are 3 feet in diameter). The locality is about 450 feet above the Bonang river.

Unless these boulders are, as suggested, remnants of Devonian heavy conglomerates (they are probably of glacial origin), it is difficult to conceive of fluviatile agencies transporting them along a comparatively flat valley such as existed *in situ* during Miocene times. A little gold has been obtained in some of the lighter gravelly wash associated with the larger boulders.

Metamorphic.

On the McCulloch Ranges, running south from Mt. Ellery, is a broad band of metamorphic schist and gneiss, apparently metamorphosed Silurian. The central mass is a coarsely siliceous gneiss, the siliceous material standing out in weathered samples in wavy lines. On either side is a band of micaceous schist, and outward from this, nodular schist and phyllites. The difference between this mass and the metamorphism exhibited along the contact with the hornblendic granites, is that in the latter the adjoining slates or sandstones are only altered for a short distance from the contact—in the former, the alteration has taken place along a north and south line over a large area. The lithological character of these metamorphic rocks at once places them on the same stratigraphical horizon as the Omeo metamorphic schists. Here, as elsewhere (in the Australian Alps), the approach to the metamorphic schists is marked by frequent quartz segregations along the margin of the schistose area. At Mount Raymond are numerous quartz diorites and felstones, apparently associated with an intrusive mass of Devonian age *in situ*.

Pliocene and Pleistocene.

The bouldery wash overlying the yellow miocene limestones and clays may be taken as a Pliocene. The deposition of these washes may be said to have taken place during an area of great rainfall. They are widely distributed along the coast regions of Gippsland, and are overlaid by the sandy coast deposits, which are probably Pleistocene and recent. The rich soils on the Snowy, at Orbost, and in the Bemm and Cann valleys, McCulloch Ranges, &c., are all younger formations.

Auriferous Areas.

The only metal mined for within the area is gold, and principally in the Bendoc and Bonang districts north of the Coast Range. Here both quartz and alluvial workings occur. Although the prospecting parties have discovered many new auriferous localities on the south side of the Coast Range, no payable goldfields have yet been opened up. The upper portion of the Bemm, as at Combinebar Creek, contains alluvial gold in the creek flats; while recently, the prospectors, under control of Mr. Norman Whitelaw, leader of track-cutting parties, found rich specimens in the

McKenzie, a western tributary rising in the McCulloch Ranges.

In the upper tributaries of the Broadribb, alluvial gold has also been found towards the Coast Range. At both the McKenzie, Combinebar, and Upper Broadribb a legitimate field exists for quartz prospecting, the geological conditions being favourable in each place for such discoveries. It is on the north side of the Coast Range that payable alluvial and quartz gold is found.

The Queensborough, Back Creek, Little River, Bendoc, Delegate, and Bonang Rivers have all been worked successfully for alluvial gold, and at present reefs are being worked in the Bendoc and Bonang valleys. In the former, the Eclipse, Morning Star, and Come Love mines; and in the latter, the Rising Sun, Duke of Westminster, Crœsus, New Chum, Exhibition, and Young Australian. Most of these mines are in slate and sandstone formation, in some cases, as in the Rising Sun, heavily charged with pyrites and the joints coated with graphitic substance, rendering the ore refractory. Chlorination works, according to the Newbery-Vautin process, are being erected in the district. On the Snowy River are some cupreous lodes, which have not yet been mined. The original observations of that eminent geological observer, the Rev. W. B. Clarke, M.A., on the Bendoc auriferous areas, and his remarks as to future discoveries, have been amply borne out by recent mining developments. As one of the pioneers of geological research in Australia, his work stands, in the light of recent examinations, a model of patient and painstaking observation and sound geological reasoning. It must be borne in mind that Mr. Clarke did not follow the pick of the miner in these areas, but was in advance of such. I am confident the members of the Royal Society will pardon this digression from the subject matter of my paper, in the humble endeavour to do justice to the memory of one of Australia's scientific pioneers.

In a future paper, on the eastern portion of the county, I will endeavour to summarise the observations I have made on the physiography of the area, dealing at greater length with the meteorology, and also the mineralogy. The present article may serve as an introduction to the physiography of a little-known region of Victoria.

NOTES FROM THE BIOLOGICAL LABORATORY OF THE UNIVERSITY OF MELBOURNE.

By W. Baldwin Spencer,

Professor of Biology in the University of Melbourne.

(1) *On the presence of a Fluke in the Egg of a Fowl.*

I owe the specimens, upon examination of which this note is founded, to the kindness of Miss Stone, of St. Kilda, by whom they were found, and to whom my best thanks are due, for the very kind and untiring assistance which she rendered in searching for the animals in a great number of eggs. Miss Stone was successful in finding the living Trematode in three eggs and undoubted traces of the animal in numerous others obtained both in Melbourne and Ballarat, and she has thus succeeded in showing that the animal, which has been but comparatively rarely recorded before from the hen's egg, is probably not infrequently present in this position in Australia, and that its ova protected in their hard cases, are really often to be found in the hen's egg. The animal itself was first described and named by Rudolph as occurring in the bursa fabricia of different birds, and hence the adult on rare occasions apparently travels up the oviduct and reaching the part in which the "white of the egg" is formed, becomes entangled in this and carried down again, till finally the shell is secreted on the outside and the animal enclosed. The fluke was close to the ovum in the centre, and therefore must have travelled a considerable distance up the oviduct, or may have worked its way in towards the centre, after deposition of the egg. In the majority of cases there were present in the eggs what were undoubtedly remains of flukes in a more or less decomposed state. Their nature was rendered evident by the presence of the very characteristic ova of the flukes with the minute oval brown-coloured egg cases. How long these ova could remain alive, and whether when swallowed by some other animal they would develop, it is of course impossible to say, without experiment.

The adult fluke is at most not more than $\frac{1}{8}$-$\frac{1}{4}$in. in length. The alimentary canal has the usual form. The ovary is a racemose gland surrounding and opening into the part where the two ducts from the yelk-glands join and the uterus arises. The much-coiled uterus is full of ova with brown shell cases, and runs forward to open, not close to the male organs, but, as can be seen both in the whole animal and by means of a continuous series of transverse sections, anteriorly by the left side of the head sucker. The three adult animals examined agreed in this respect: in the whole animals the eggs could be traced forwards to the sucker, but this might of course have been due to their lying in a groove on the surface; sections showed that this was not so, but that the oviduct ran forward. The testes are two large oval bodies, one on each side of the ventral sucker. sucker. Their ducts unite and open in the usual position.

The excretory vesicle is well developed, and has strongly muscular walls. In sections the median canal can be traced as a single duct as far forwards as the ventral sucker.

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(2) *On the presence of a Pentastomum parasitic in the Lung of the Copper-head Snake (Hoplocephalus superbus).*

My attention was first drawn to this arthropod by my friend and pupil, Mr. Dombrain, who noticed its presence when cutting open a snake on King Island in November, 1887. Further searching showed me at once that the copper-head snakes of the island were infected by the parasite, which lives in their lungs. In one snake I counted no fewer than 129 specimens in the lung, and yet to all appearance this animal was perfectly healthy. When living they are of a bright red colour, due to the amount of blood sucked into the body from the lung of the snake.

The parasite lies with its head buried in the lung tissue and firmly attached by means of its four very definite hooks. The female, which is much the largest, measures when full-grown some 2 inches in length, and has from about 60-70 very distinct annulations on its body. The mouth is ventral and anterior, and apparently plugged by a somewhat triangular-shaped piece of tissue with chitinous edges. The anus

is posterior and terminal, and the generative opening placed ventrally some seven segments from the posterior end.

The male is much smaller and less frequently found than the female, from young forms of which it can easily be distinguished by the male genital opening, which is situated anteriorly on the ventral surface.

The body wall is composed of a very thick cuticle, through which open very numerous multicellular glands. Within the glandular layer, beneath the cuticle, lie the bands of circular and longitudinal muscles.

The alimentary canal consists of the œsophagus running upwards, lined with a definite cuticle, and opening on a papilla into the intestinal tube, which runs straight back dorsally to open at the terminal anus. The intestine is enclosed by the highly developed salivary (?) glands, which are formed of large nucleated cells, amongst which ramify numerous ducts. The ducts all unite on either side and run forwards into the head, the one of each side opening, apparently, on a slight papilla above the hooks.

In the female the ovary is single, and in the median line dorsally. Two oviducts unite at a point where are two bladder-like receptacula, and from here the uterus arises, which is much coiled and crowded with eggs, occupies a great part of the cœlom, and opens finally close to the posterior end.

The specimen resembles closely the form described by Leuckhart as *Pentastomum tæniöides*, but is not quite similar to this apparently, and will be determined and described more fully subsequently.

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(3) *On the structure and presence of the Cestode Amphiptyches parasitic in Callorhynchus Antarcticus.*

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(4) *Note on some Actinian Larvæ parasitic upon a Medusa from Port Phillip.*

By ARTHUR DENDY, M. Sc.

Demonstrator and Assistant Lecturer in Biology in the University of Melbourne.

[Read November 15, 1888.]

It has been known for a long time that the larval forms of certain species of Actinians are habitually parasitic upon Medusæ, thereby obtaining the advantages of free swimming without being obliged to possess locomotive organs of their own. I need enter into no details as to the observations of previous writers on this subject, as Professor Haddon* has already published a most valuable bibliography of larval Actiniæ parasitic on Medusæ.

According to this author, such parasitic larvæ have hitherto been found in North European seas, in the Mediterranean, on the coast of New England, and in the Southern Ocean. The object of the present brief note is to place on record the discovery of three parasitic Actinian larvæ on a Scyphomedusa from Port Phillip, which I had the good fortune to find on the occasion of the University Science Club's excursion to Cheltenham.

The Medusa upon which the specimens were found is a small monostomatous form about two inches in diameter. The bell is flattened, and the margin is notched into eight lobes, each subdivided into two halves by a deep indentation containing a tentaculocyst. The mouth is squarish, and at each corner is a rather large, somewhat flattened projection, with a much folded or crenated margin. These four projections are, of course, the oral arms. From the under surface of the Medusa, about half way between the oral arms and the margin, there arises a circle of very numerous, long, slender tentacles, arranged in eight horseshoe-shaped groups placed adradially. Each group contains about twenty-five tentacles, and the concavity of the horseshoe faces outwards. In the living animal the bell has a yellowish-brown tinge; the oral arms are of a warm sepia colour, sometimes with a

* Scientific Proceedings of the Royal Dublin Society, N. S., vol. 5, p. 473.

touch of crimson lake; and the long, slender tentacles are pale, dull pink. The species is one of the *Discomedusæ*, and belongs apparently to Hæckel's genus *Desmonema*.

I have given this brief description of the Medusa in the hope that local naturalists may be induced to search for the species and its interesting parasites.

The largest of the three Actinian larvæ, all of which were obtained from the same specimen, was attached by its own oral surface to one of the oral arms of the Medusa. The position of the two smaller ones is a little doubtful—they were only observed after the animal had been preserved in spirit.

I will describe the three parasites in order, commencing with the youngest:—

(a) The youngest example is approximately hemispherical in shape, and the diameter of the oral disk is about 3 mm. after preservation in spirit. The surface of the column is marked by only a few transverse and longitudinal furrows. No terminal pore was visible under the dissecting microscope, and it may be pretty confidently asserted that none exists. Twelve tentacles are already present as short, thick, translucent outgrowths around the margin of the disk. Within these, there is an inner circle of twelve cushion-like swellings, apparently produced by division of each tentacular outgrowth into an inner and an outer lobe—the outer lobe forming the true tentacle, and the inner lobe the cushion-like swelling. Some of the cushion-like swellings are not yet completely marked out. The mouth is in the centre of the oral disk, and furrows radiate towards it from between the tentacular lobes. Transverse sections demonstrate the important fact that twelve mesenteries are already present. They also show that the longitudinal furrows on the outer surface of the column correspond in position to the insertion of the mesenteries.

(b) The next specimen is rather more advanced in development. The general shape is still hemispherical, and the diameter of the disk has increased only slightly, to about 4 mm. The transverse and longitudinal furrows on the surface are more strongly developed, but this is probably in part, though not entirely, due to the action of the reagents employed. The twelve tentacles have elongated somewhat and become more conical, and the twelve cushion-like outgrowths on the disk inside them are very well formed.

(c) I was able to observe the largest specimen in the living condition. I have already stated that it was attached by its oral disk to an oral arm of the Medusa. Its general form was elongatedly conical, swelling out somewhat beneath the insertion of the tentacles, and narrowing greatly at the other end of the column; but doubtless the animal is capable of changing its shape to a considerable extent. The tentacles of the living animal were of a very dull, pale, bluish-grey colour. The column was very dull, reddish-brown, almost flesh-coloured, and showed longitudinal and transverse markings, probably corresponding to the grooves observed in spirit-preserved specimens. The conical tentacles are still twelve in number, but more elongated than in the earlier stages. Internally, at the base of each, is a saccular outgrowth corresponding to the similar cushion-like outgrowths noticed in the younger larvæ, but considerably larger. After preservation in spirit, the animal measured about 7·5 mm. in length and 6 mm. in diameter of the oral disk, excluding the tentacles.

I at first thought that my specimens were referable to the well known genus, *Halcampa*, and even to the species *H. clavus*, of which there is a good figure in Professor Hertwig's Report on the Challenger Actiniaria (Plate 3, Fig. 4). The presence of the remarkable outgrowths at the bases of the tentacles, however, shows that they cannot belong to that species, and even makes the generic identification doubtful. I do not think that these curious outgrowths have hitherto been observed in any other forms; according to Haddon's figures they are entirely wanting in the British *Halcampa chrysanthellum*. They may possibly serve as adhesive organs, by means of which the parasite is attached to its host.

Actiniæ are very difficult animals to preserve, and, although I took great care, I was not very successful in the preservation of my specimens. I therefore postpone giving figures and an account of the histology of the species, until better material is forthcoming. Meantime, it seemed to me worth while to call attention to the existence of these interesting parasites in Port Phillip, and to request other naturalists to search for them should the opportunity arise. It still remains to discover the adult Actinian of which they are the larval forms.

MEETINGS OF THE ROYAL SOCIETY.

1888.

[N.B.—The remarks and speeches in the discussions are taken down verbatim by a shorthand writer, and afterwards written out at length with a typewriter, for reference and reproduction, if required; and therefore, more is seldom given herein than an indication of their general drift. If any person should wish to refer to the verbatim report, he can apply to the Secretary to the Society, who will give him an opportunity of perusing and copying it, or if he resides at a distance, so much as he requires will, upon payment of the cost of reproducing it, be forwarded to his address.]

ANNUAL MEETING.

Thursday, March 8th.

The President in the chair.

Annual Report.

The Council of the Royal Society of Victoria presents to the Members of the Society the following Report for 1887. The following papers were read during the session, viz.—

On the 10th of March, 1887, a paper by the Rev. D. Macdonald, of Fate, New Hebrides, "On the Oceanic Languages, Semitic," was presented and read in abstract by Dr. Wild. Mr. H. T. Tisdall read "Notes on Fungi in Mines."

On account of the lamented death of Mr. S. W. McGowan, an old and valued member of the Society, the April meeting was suffered to lapse.

On the 12th of May, "Notes on the Occurrence of Glaciated Pebbles and Boulders in the so-called Mesozoic

Conglomerate of Victoria, contributed by Mr. E. J. Dunn, F.G.S., was read by Mr. Griffiths; and Mr. H. T. Tisdall read a second paper "On Fungi growing in Mines." Mr. A. H. S. Lucas, M.A., B.Sc., also read a paper "On the Production of Colour in Bird's Eggs."

On the 9th of June, Mr. H. S. Griffiths, F.R.G.S., read a paper "On the Geology of the Portland Promontory, Western Victoria."

On the 14th of July, Professor Andrew, M.A., read some "Notes on the Value of J and the value of g;" and Mr. Ellery, F.R.S., F.R.A.S., gave an "Account of the proposed Photographic Charting of the Heavens."

On the 11th of August, Professor W. C. Kernot, M.A., C.E., read some "Remarks on the Early History of the Brennan Torpedo," and Mr. C. R. Blackett, F.C.S., read "A Note on some determinations of Chlorine in the Water of the Yarra." Mr. A. W. Howitt, F.R.G.S., then read a paper "On certain Metamorphic and Plutonic Rocks at Omeo."

On the 8th of September, Baron Von Mueller, K.C.M.G., F.R.S., &c., presented "Descriptive Notes on a Victorian *Haloragis* and a *Pluchea*," with some general considerations on systematic phytographic arrangements. Professor Kernot also described and exhibited some Models of Engine Governors and Dynamometers.

On the 13th of October, a paper was presented and read by D. McAlpine, Esq., entitled "Observations on the Movements of Detached Gills, Mantle Lobes, Labials Palps, and Foot, in Bivalve Molluscs."

On the 10th of November, Professor W. Baldwin Spencer's paper on "The Structure and Classificatory Position of *Megascolides australis*," was read in abstract by Mr. A. H. S. Lucas, in the absence of the author, and Mr. G. R. B. Steane read a paper "On Rainfall and Flood Discharge." Dr. Jamieson also read an account of "Some Experiments on the range of Action of the Digestive Ferments."

On the 9th of December, at the Annual Conversazione, the President read his Annual Address, and Professor Spencer described the *Megascolides australis;* and on the 15th of December, Baron von Mueller's description of some Papuan Plants was presented, and the President read a

paper contributed by Mr. T. Wakelin, B.A., of Greytown, New Zealand, on "The Production of the Tides, Mechanically Considered."

Your Council has departed from the usual custom, by holding the Conversazione at the end of the session in December, and judging by the great success of the meeting, the change may be regarded as an improvement. The principal objects in doing so were that the proceedings of the whole year could thus be noticed and reviewed by the President in his Address, and that the year's Transactions might be completely published in the annual volume during the recess, instead of combining in the same volume the Annual Report and proceedings of one year with the transactions of the preceding year. It may probably be found better another year that the Monthly Meeting in December should precede the Conversazione instead of being held the following week.

Your Council has to congratulate the Society upon one important step in the right direction having been made during the past year. The Microscopical Society of Melbourne has found it to its advantage to combine with the Royal Society and to form Section D, as provided for in the Laws of this Society. This brought an accession of thirty members to the Royal Society. Eleven other members and three honorary members of the Microscopical Society were already members of the Royal Society, and did not require to be elected. It is to be hoped that other societies will follow the example of the late Microscopical Society, and illustrate the truth of the old adage that union is strength.

The following members and associates have been elected during the year:—Messrs. A. H. Jackson, B.Sc., F.C.S.; J. B. Lewis; J. J. Wild, Ph.D., F.R.G.S.; and W. H. Irvine, on the 10th of March. Professor D. O. Masson, as a member; Mr. C. H. Richards, as a country member; and Messrs. Pietro Baracchi, James Blackburn, Rev. A. W. Cresswell, Mr. W. S. Dawson, Dr. Thomas Porter, and Mr. G. A. M. Pringle, as associates, on the 9th of June. Professor W. Baldwin Spencer was duly elected a member on the 14th of July, together with the following members of the late Microscopical Society:—Messrs. M. J. Allan, W. W. Allan, W. H. Archer, F.L.S., F.I.A., &c.; F. H. Baker, W. M. Bale, Wm. Ball, F. Barnard, W. R. Bennetts, Jun.,; W. W.

Bowen, Dr. Clendinnen, Messrs. J. W. Davy, James Dawson, W. Fox, J. Gabriel, T. Gaunt, R. Haig, J. Lindsay, W. T. Moffat, J. O. Moody, Dr. Myles, Messrs. W. E. Pickles, J. E. Prince, Dr. T. S. Ralph, O. A. Sayce, Geo. Swift, C. A. Topp, M.A., LL.B.; W. Welchman, J. Wing, and W. W. Wooster.

Your Council has, however, to deplore the loss by death of several valuable and respected members. Sir Julius Haast, F.R.S., C.M.G., of New Zealand, honorary member; Dr. Solomon Iffla, one of the original members of the Society; Mr. S. W. McGowan, an old member of the Council; and Mr. E. S. Parkes, a member of many years' standing.

Your Council, as a body, attended the Jubilee Levee at Government House, and on that auspicious occasion, presented a short address tendering its humble duty to Her Majesty, and duly received in November a gracious reply thereto, which was read to the meeting in December.

Your Council has entered with pleasure into a proposal from the Field Naturalists' Club, supported by the Academy of Art and the Royal Geographical Society, to unite with them in urging upon the Government the reservation of Wilson's Promontary as a National Park. A deputation from these bodies had an interview with the Minister of Lands on the 21st instant, and it is thought that there is every prospect of the project coming to a successful issue.

The Australian Antarctic Exploration Committee has not succeeded in effecting any arrangements for utilising the present season, but continues to collect information relating to the subject of its labours. It finds that negotiations for such undertakings are always difficult and protracted, particularly when lacking active public support. It has, however, just received a spontaneous declaration of earnest sympathy from one influential public body, and expects that that will soon be followed by others.

Your Council has also deemed it desirable to expand the operations of the Society, by appointing on July 14, a Committee consisting of Mr. W. M. Bale, Rev. A. W. Creswell, M.A., Dr. MacGillivray, Professor Spencer, Mr. C. A. Topp, M.A., LL.B., Mr. A. H. Lucas, M.A., B.Sc., and Mr. J. B. Wilson, M.A., to undertake a systematic biological survey of Port Phillip, and also, by making to the Committee a grant of £50 for the purpose.

The result of the work of this Committee formed an instructive exhibit at the Conversazione in December, and its Progress Report will be found appended to the proceedings in the forthcoming volume of the Society's Transactions.

The Treasurer's balance-sheet is appended.

The account of the Davy Fund has been closed by the payment to Mrs. Davy, in July last, of the balance of the principal with interest to date.

One of the three debentures shown last year as outstanding, was since found by Mrs. S. W. McGowan, among her late husband's papers, and its amount with interest to the date when the debentures were called in, has since been paid to her. There are, therefore, still two debentures and interest outstanding.

In view of the new item of expenditure on the biological survey of Port Phillip Bay, and of a probable further increase of expenditure in original research and other ways, your Council has deemed it advisable to set apart on deposit at interest, a sum of £300 as the nucleus of a fund for publishing and research, with a view to its increase by yearly additions of £100 or £200, so that the interest may in time prove sufficient for those important objects of yearly expenditure. The balance on hand is therefore reduced to £179 19s. 10d., as compared with £545 19s. 6d. last year. The early publication in September last of half the year's Transactions, and the grant to the Port Phillip Biological Survey Committee, account for more than the amount of the reduction of the balance.

Dr. *The Hon. Treasurer in Account with the Royal Society of Victoria.* Cr.

To Balance from 28th Feb., 1887, as per last Balance-sheet						£545	19	6		
,, Government Grant—										
Balance of Vote for 1886-87					£50	0	0			
Portion of do. 1887-88					150	0	0			
								200	0	0
,, Entrance Fees (5)								10	10	0
,, Subscriptions—										
70 Ordinary					147	0	0			
26 Country					27	6	0			
44 Associated					46	4	0			
2 Do. (Half-year)					1	1	0			
Arrears					34	13	0			
								256	4	0
,, Rent and Gas								13	0	0
,, Sale of Transactions								1	1	3
,, Interest								25	12	6
								£1052	7	3

By Printing and Stationery	£233	3	0
,, Architect's Charges	13	4	0
,, Books	1	16	0
,, Purchase of Early Transactions	9	0	0
,, Binding	1	1	0
,, Freight and Charges	2	16	9
,, Conversazione, &c.	32	10	9
,, Expenses of Port Phillip Biological Survey	44	11	6
,, Hire of Room for Antarctic Committee	1	11	6
,, Rates	5	10	0
,, Gas and Fuel	7	16	2
,, Clerical Assistance	100	0	0
,, Records of Proceedings	21	0	0
,, Hall-keeper	6	0	0
,, Collector	34	6	11
,, Insurance	3	10	0
,, Postage	34	4	5
,, Outstanding Debenture (1) and Interest	9	4	0
,, Petty Cash, Advertising, &c.	11	0	3
,, Transferred to Publishing and Research Fund	300	0	0
,, Balance in Bank, 1st March, 1888	179	19	10
	£1052	7	3

Compared with the Vouchers and Bank Pass-book and Cash-book, and found correct,

H. MOORS,
HON. TREASURER.

27*th February*, 1888.

(Signed) JAMES E. GILBERT,
ROBERT E. JOSEPH,
} AUDITORS.

Dr. PUBLISHING AND RESEARCH FUND. Cr.

Transferred from General Fund	£300	0	0	By Balance in Bank	£300	0	0

The Hon. Treasurer in Account with the Fund in Aid of the Widow of the late Dr. Davy.

To Balance in Bank	£100	0	0	By Paid to Mrs. Davy	£106	0	0
,, Interest	6	0	0				
	£106	0	0		£106	0	0

Examined and found correct,

H. MOORS,
Hon. Treasurer.

27*th February*, 1888.

JAMES E. GILBERT,
ROBERT E. JOSEPH,
} Auditors.

Dr. STATEMENT OF LIABILITES AND ASSETS. Cr.

LIABILITIES.				ASSETS.			
To Debentures (2) outstanding	£10	0	0	By Outstanding Subscriptions (estimated)	£40	0	0
,, Interest unclaimed	8	8	0	,, Rents due (estimated)	20	0	0
,, Estimated Outstanding Liabilities	50	0	0	,, Hall, Library, and Furniture	3700	0	0
,, Balance	4171	11	10	,, Balance in Bank, Publishing Fund £300 0 0			
				General Account 179 19 10	479	19	10
	£4239	19	10		£4239	19	10

1*st March*, 1888.

H. MOORS,
Hon. Treasurer.

On the motion of the President, seconded by Mr. White, the Annual Report, as printed and circulated, and amended as under, was received and adopted. It was agreed that a reference to the death of Professor Balfour Stewart should be inserted immediately after the obituary paragraph.

It was also agreed that the name of Mr. A. H. S. Lucas, which had been accidentally omitted from the list of members of the Committee for the Biological Exploration of Port Phillip, should be inserted.

After some discussion with regard to the publication of a catalogue of books in the library, the office-bearers for the coming year were elected as follows :—

President, Professor Kernot, M.A., C.E.

Vice-Presidents, { E. J. White, Esq., F.R.A.S.
J. Cosmo Newbery, Esq., C.M.G., B.Sc.

Hon. Treasurer, James Jamieson, Esq., M.D.

Hon. Librarian, J. E. Neild, Esq., M.D.

Hon. Secretaries, { H. K. Rusden, Esq.
F. Barnard, Esq.

Members of Council, R. L. J. Ellery, Esq., F.R.S., F.R.A.S.; G. S. Griffiths, Esq., F.G.S.; Prof. Orme Masson, M.A., D.Sc.; H. Moors, Esq.; J. T. Rudall, Esq., F.R.C.S.; Prof. W. Baldwin Spencer, B.A.

The meeting then resolved itself into an ordinary meeting, and the minutes of the last ordinary meeting were read and confirmed.

Mr. James Wilson was elected as an associate.

The PRESIDENT read a letter received from Professor Liversidge in reference to the Australasian Association for the Advancement of Science. The letter was in reply to one addressed by Mr. Rusden to Professor Liversidge regarding the proposal made by the Exhibition Commissioners, that a gathering of scientists should be held in Melbourne some time within the period set apart for the Exhibition. The President added that it had already been decided to hold the first meeting of the Association in Sydney, in August or September, and it remained to be seen how the desire of the Exhibition Commissioners could be met.

Mr. JENNINGS' paper on "Irrigation" was postponed, in the absence of the author from the colony.

Dr. WIGG read a paper on "The Proposed Introduction of New Diseases into Australia."

The PRESIDENT said it would be agreed that this question was one of great importance, indeed of urgency at the present moment. The steamer on which M. Pasteur's emissaries had embarked was close at hand, and unless some step were taken the experiment would be tried. Of course it was possible that nothing would come of it, that it would hurt no one, not even the rabbit. It might affect the rabbit and no one else. Yet there was reasonable probability, as Dr. Wigg had stated, that it would do a great deal of harm, in any event it was a step that should not be taken blindly.

Mr. MARKS was glad to be able to say that Dr. Wigg in his paper mentioned a great many points on which he (Mr. Marks) had laid great stress, in a letter written to the Chief Secretary. If the influence possessed by the Royal Society were brought to bear on the Government it might be the means of preventing the introduction and extension of cholera microbes in the colony.

Dr. JAMIESON said there could be no doubt of the importance of the question Dr. Wigg had dealt with that evening. Dr. Wigg had been good enough, at comparatively short notice, to undertake to bring the matter before the Society. The fact that the paper was not on the notice paper might have prevented some from trying to make themselves better acquainted with the subject. However, it was but fair that the matter should be brought before this, the leading Society of the colony, as the Society was known to have weight with the Government. He had been endeavouring, with such opportunities as he had had, to make himself acquainted with the present state of knowledge of this question. On some of the points Dr. Wigg had referred to, he had been able to collect some important information, which might be useful in connection with this discussion. Firstly, with reference to the nature of the disease. As far as he understood it, it was not cholera at all. He understood that it got its name—fowl cholera—from the fact that it occurred with great virulence and spread violently in France at a time when the genuine cholera was very prevalent. It had not the symptoms of cholera, and in other countries than France it was not called cholera. In Germany it was called "fowl typhoid," or "bird typhoid." Dr. Wigg referred to the fact, as he

said, that information had been withheld. He did not know how far it was proper to say that it was withheld, deliberately withheld, for some purpose; but certainly, they had not got specific information as to the spread of the disease from fowls to other birds. In the year 1883 a report was made by a well-known veterinarian, in a fowl-fancier's journal, published in Dresden, as to an examination which had been made of the bodies of a large number of birds that had died. His report was, that out of 365 birds examined after death, no fewer than 122 had died of this fowl typhoid. Included in the number of birds that had died of this disease were 79 fowls, 17 pigeons, 9 geese, 8 turkeys, 5 ducks, 3 ordinary pheasants, and a foreign pheasant. Considering that only domesticated or semi-domesticated birds were likely to be found dying of disease, and have their bodies examined, it might be taken for granted, judging from the large variety of birds that had been affected, as stated, that the disease would spread through all kinds of birds. It had not been proved that it affected any special kind. In so far as birds were known, there was apparent evidence that it would spread to any kind. It could not be limited to fowls and rabbits. If it once got into this community it might possibly sweep over the country, and, if not exterminate, gradually diminish the number of both tame and wild birds. That was an important point, and might be taken as supplying evidence that Dr. Wigg and himself thought should rightly and properly have been supplied. There was another important matter to be considered, and that was the relation of this disease to diseases in other animals. He found that in the year 1878 a disease was very prevalent in Germany amongst game animals, particularly deer. A very large number died from some not well understood epidemic disease. An inquiry into the nature of that disease was conducted by a well-known veterinarian. His first suspicion was that it was anthrax. He did find, correctly or not, that there was abundance of room for a difference of opinion. He found an organism that he considered was the cause of the disease. If not identical with the organism found in fowl cholera and the disease affecting rabbits, yet it bore a very close resemblance to it. The disease in fowls, the disease affecting rabbits, and one called "swine disease," all bore a great similarity as regards the organisms present in all of

them. More recently the question had been taken up again. He held in his hand a very full summary of papers published on the subject in Berlin, at the end of 1886, by a well-known authority on this particular question. His inquiry was as to the relation probably existing between this disease and others. His general conclusion was, that the swine sickness, probably also the rabbit and fowl cholera, were only various manifestations of a disease which he would describe in a general way by one name. Therefore, though it might be said that M. Pasteur is a great discoverer, anxious to gain further fame, yet there was reason to suppose that some risk would attend the introduction by him of the fowl cholera. A serious responsibility would be incurred by the Government of this or any other colony were they, without very careful inquiry, to allow experiments to be made on this continent in the rash way proposed. However, it was somewhat doubtful, supposing the disease were introduced, whether or not it would serve the purpose of destroying the rabbits. Dr. Wigg had clearly pointed out that the experiment in France was made under conditions different to those which were to be met with here. The result of that experiment was simply that a certain number of rabbits had been poisoned and nothing more. It had been shown that the disease would be spread over large areas by the ordinary means of contagion. No satisfactory proof had been given that it would serve the purpose intended, and in view of that fact, and of the supposition that the disease might spread to other animals and birds, the matter was one which should be seriously considered. He did not agree with many who, in speaking and writing on the subject, had stated that the disease would acquire here new features, of special virulence for instance. It was very true, as Dr. Wigg had stated, that a great many deaths from measles occurred in Fiji, but apart from the fact that measles were then introduced for the first time, it was known that the natives deliberately refused to be treated, and exposed themselves to dangers such as would cause disease to be fatal in any country. Still it must be borne in mind that when scarlet fever came into this country from Europe, and when its nature was first discussed here in 1854 and 1855 it was quite a mild disease. It did not rage then at all. The same held good of measles, which always was an extraordinary mild disease in Australia.

So far as his experience went, he was not aware that any disease introduced into Australia had shown more virulent properties here than it had in other parts of the world. He did not think the fowl cholera would acquire new properties here—would become extraordinarily virulent, or would be the cause of effects unknown elsewhere. It was now recognised that fowl cholera was making great havoc amongst domestic fowls and birds in France and Germany, and probably in other countries of Europe, and that in all likelihood it would spread to a considerable extent here, though it might happen, on account of our large areas, that it would not spread so readily as it did in the more crowded parts of Europe, where fowls were met with at every few paces all over the country. He did not know of any evidence showing that the disease would spread to human beings. It had been said that there had been ample opportunities for such a power if it existed to have been developed in the old countries, and it was not at all likely that such a property would be developed by the mere introduction of the disease into Australia.

Mr. C. R. BLACKETT thought that Dr. Wigg's paper was timely. It would be better to bear the ills they had, than fly to others they knew not of. It should be known that M. Pasteur had saved millions to France. He had benefitted the wine culture by investigating the disease in vines, and had discovered the cause of disease in silk worms. Though he had gained the respect and even the confidence of scientific men, still they were not to accept without question all that he proposed. Dr. Jamieson had alluded to the fact that various diseases in certain animals were modifications of the same thing, but the investigations of the ablest microscopists seemed to indicate that they were quite distinct. He agreed with Dr. Wigg and Dr. Jamieson that the Government were bound to take steps to prevent the introduction into the colony of the form of disease proposed to be introduced by M. Pasteur, except under the most stringent conditions. It might be advisable to quarantine M. Pasteur's emissaries at Flinders Island. If the fowl cholera would kill the rabbit, and could be propagated amongst rabbits, and if its origin was with the winged tribes generally, would it not go back to them? That appeared to be the logical conclusion. He thought M. Pasteur had not thoroughly recognised the enormous distances in this country, nor that Australia was sparsely

populated with people, and that the rabbits were scattered over wild and scarcely-populated districts. While the microbes might kill rabbits in one burrow, how could the disease be propagated for long distances? Certain rabbits would escape, and their fecundity was well known. Those were matters for future consideration, but it was quite right that a warning note should be sounded.

Mr. BOSISTO thought the Society was greatly indebted to Dr. Wigg for bringing the matter forward, inasmuch as the results of the introduction of the disease might be very serious. Birds and animals might be affected by the disease. He would refer to Pasteur's experiments in the 19 acres already alluded to. It was well known that if a field containing a large number of rabbits were walled in the rabbits could be destroyed by means other than that adopted by Pasteur, and just as rapidly as he destroyed them. He (Mr. Bosisto) was not speaking ignorantly on this subject, as he himself had had to deal with 11½ square miles of Mallee country, on which he had seen tens of thousands of rabbits—not altogether on that block, but in and around it. By paying attention to the matter of getting rid of them he had so far succeeded, that instead of their now being thousands of rabbits on his land he did not think that 500 could be found. Endeavours should now be made to induce the owners of land throughout Australia to undertake one uniform and regular system of destruction. There were peculiar circumstances connected with M. Pasteur's experiments in the 19-acre block. Firstly, the rabbits had eaten up the whole of the vegetation, so that when the clover, over which the liquid containing the microbes had been spread, was placed in the enclosure, they ate it greedily, and death resulted in a large number of cases. He (Mr. Bosisto) and others in Victoria had, in the dry seasons when the ground was bare, adopted somewhat similar means, with equally good results as regards the rabbits on this ground. In summer, when there was plenty of green grass which the rabbits liked to nip from the living plant, the only thing they found could be done was to place bi-sulphide of carbon in the warrens; but when the ground was as bare as it was for M. Pasteur's experiment then they killed them by thousands. Little heaps of as much chaff as could be got into a tumbler were placed near the warrens, and upon those heaps were poured a weak solution of arsenic. Simple as this remedy seemed,

it did what was desired. Thousands and tens of thousands of rabbits were killed after eating the chaff, which they did ravenously. They could get nothing else. On Madame Pomeroy's 19-acre block they could get nothing more than what was given them by M. Pasteur. His (Mr. Bosisto's) candid opinion was that we had the remedy in our own hands. We wanted neither microbes nor any other dangerous material imported into this country. He made these observations to show that while we possessed an animal that bred rapidly, yet we possessed a remedy, and did not require to introduce others. He hoped the steps would be taken to carry out Mr. Blackett's suggestion of quarantining. If the imported disease destroyed the birds, a great evil would be done to the community, as locusts, grasshoppers, and other insects would increase. His land, to which he had referred, was now looking green and beautiful, the rabbits having been greatly lessened in numbers by the adoption of the remedy spoken of. One day the locusts swept across the whole 600-acre block, and demolished every particle of green thing there, and still went on. Yet crows and other birds followed and feasted on the locusts. The poisoned chaff which the rabbits ate was spread so carefully, that very few birds were killed by it. The rabbits, however, died in thousands.

Dr. RUDALL.—If such a disease as fowl cholera were introduced he did not think it was in the power of any human being to say where it would stop. In old countries it could be estimated, but not in a country like Australia. Dr. Wigg had instanced the occurrence of measles in Fiji, and stated that it was a new disease there, and had proved fatal in a large number of cases. Dr. Jamieson seemed to think that the disease had proved fatal in so many cases because of the great carelessness shown on the part of those who were attacked. He did not think that was a full explanation of the occurrence. Many years ago measles were introduced into the Faroe Islands. That disease had not been known there in the memory of man, yet it was remarkably fatal, and it did seem therefore that when disease fell upon virgin soil it was very likely to be much more fatal than among communities who had been habituated to it.

Mr. G. S. GRIFFITHS moved, "That having heard Dr. Wigg's notes on this subject, and the remarks made by the other gentlemen present, the Royal Society

respectfully advises the Australian Governments to refuse their permission to any person to introduce any form of disease for the purpose of checking the rabbit plague, until the whole question has been fully considered."

Mr. JACKSON seconded the motion. Dr. Wigg had done a great service to the Society in calling attention to the subject. He gathered from the remarks that had been made, that it was not yet certain whether or not this disease would be communicated from one set of rabbits to another set. If it were not so communicable, then its value as a means of ridding the country of the pest would be nil. If, on the other hand, it were valuable for the purpose of ridding the country of the pest, by being easily communicable, it would have the disadvantage of carrying off a great proportion of the number of domestic fowls and other birds. It seemed to him, that the people here were on the horns of a dilemma. From either point of view, it was desirable to prevent the importation of the disease into the colony.

The PRESIDENT said that before the motion was put, he would like to say a word or two. He did not speak as a medical man, nor as a biologist. He was an engineer, and, he trusted, a scientific one. It had been said, that M. Pasteur's investigations of the vine disease and the silk worm were models of scientific investigation. On the strength of that, it might be assumed that his experiments with the chicken cholera had been equally exhaustive and minute. If that were so, it was strange that no information of such an exact investigation was to be met with. An experiment, unless it were properly arranged and tried, would be simply misleading. There had appeared in *The Argus* a column or more containing the extraordinary story about the rabbits in Madame Pomeroy's vineyard. He was greatly astonished that such unscientific proceedings should be put forward as a conclusive experiment. Suppose instead that a solitary infected rabbit had been placed in that 19-acre paddock, and that then in the course of a week the rabbits had died the inference would have been different. The result obtained by M. Pasteur was in no way different from that arrived at by Mr. Bosisto simply by the use of arsenic. One of the first questions that occurred to him was, could not the same result have been obtained with any ordinary poison, and if chicken cholera was not different to ordinary poisons that were

used, what was the need of bringing it here at all? Mr. Bosisto's evidence regarding the arsenic was most important. Why go to an unknown and possibly very dangerous agent, when the desired object could be effected by a cheap and possibly safe one?

The motion was put and carried unanimously.

Thursday, April 12th.

The President in the Chair.

THE AUSTRALASIAN ASSOCIATION.

The PRESIDENT said that a communication had been received from Professor Liversidge intimating that the Australasian Association for the Advancement of Science, having been duly established, with the concurrence and support of almost the whole of the scientific and learned societies throughout the colonies, the first general meeting of the Association would be held in Sydney, on the 4th September next, and continue for several days following. The Association, it would be remembered, arose out of a proposal made by Professor Liversidge in November 1886, on which occasion a meeting was held at the Royal Society's House in Sydney, under the presidency of Mr. Russell, and at which a large number of the learned, scientific, and professional societies of New South Wales, New Zealand, South Australia, Tasmania and Victoria were represented. At that meeting it was resolved unanimously that the Association should be formed on the lines of the British Association, and that the first meeting should take place in the Centennial year, 1888. The time was approaching for the holding of that meeting, and it was hoped that the members of the Royal Society of Victoria would not be slow in supporting so desirable a movement. The Association did not propose to trench upon the operations of or interfere with any existing scientific body. Its meetings were intended to be annual, as were those of the British Association. The first meeting would be held, as already arranged, in Sydney, and the second meeting, it was almost certain, would be held in Melbourne. Those annual meetings on the lines of the British Association would unquestionably do great good. They would bring scientific men together, and would enable those who had been working on different lines to come into personal

communication. At present, the scientists of Melbourne met the scientists of Melbourne, but had not the opportunity of meeting those of Australasia. The meetings of the Association would afford that opportunity. An annual volume such as was published by the British Association would be published. The great facilities that now existed for travelling between the principal Australian colonies would promote the prosperity of the Association; in fact, he might say, they would render possible the existence of such an Association. In connection with the meetings it was proposed to have excursions to places of interest, especially of scientific interest. Therefore the meetings would not only be interesting from a scientific point of view, but would afford relaxation, health, and pleasure. The subscription was £1 1s. per annum. It was intended to pay the incidental expenses of holding meetings, printing, sending out notices and so forth, and also the expense of publishing the Transactions. Each subscriber would receive a copy of the annual volume, and, in fact, of all publications of the Association. That the movement should be warmly supported was highly desirable. It was a step in the direction of federation and of harmonious co-operation, and could not fail to be productive of good in a multitude of ways. Their Sydney friends had the right to claim that the first meeting should be held in Sydney, as New South Wales was the oldest colony, and this was the Centennial year. The movement had been fostered, and the preliminaries arranged by the scientific gentlemen in Sydney, and all that Victorians had to do was to support it as earnestly and warmly as they could. There would be a series of sections within the Association similar to those in the British Association, so that persons studying different branches of science would find a congenial sphere in which to work. The sections were ten in number. He trusted that members would not overlook this very important movement, nor allow their Sydney friends to accuse them of lukewarmness in the matter. If they paid their sub iptions, attended the meeting in Sydney in numbers, and contributed papers, they might that their Sydney friends would be greatly and that the year after they would have a successful meeting in Melbourne.

PRESIDENT then read the Annual Report of the brarian, Dr. Neild.

Mr. RUSDEN read a paper by Robert Abbott, Esq., C.E., on "The Maintenance of Energy."

The PRESIDENT remarked that there was one point in the paper with which he was not quite satisfied, viz., the mode in which the length of time necessary for the production of the features of the earth's surface and its flora and fauna was arrived at by the biologists and geologists. The physicists had certain definite data to go upon, but on the biological side he failed to see where were the data for such definite conclusions. Mr. Abbott did not seem to have given them a great deal that was new on the subject dealt with in the paper.

Mr. FRAZER thought the title of the paper incorrect; that there was nothing in it to show how energy was maintained.

Professor MASSON said that Mr. Abbott asked them to follow him in assumptions, as, for example, that the primordial matter was below possibly the absolute zero of temperature—that it was without molecular motion—which required much more justification than he had given for them.

The PRESIDENT read a paper by Mr. Newton C. Jennings, on "Irrigation and Water Supply in the Australian Colonies."

Mr. FENTON did not see anything in the paper open to discussion, and remarked on the peculiar fluctuation in the rainfall of the colony.

Mr. F. A. CAMPBELL thought that everything in the paper might be taken as a matter of course. Though the average rainfall of the colony was ample for all wants, yet in certain parts of the colony where irrigation was most necessary, it was small. Search should be made to ascertain where water existed below the surface, so that it might be tapped.

The PRESIDENT remarked that Mr. Jennings could hardly be aware of how much work had already been done. All the more important streams in the northern watershed of the colony were being gauged very carefully, and the results recorded and printed. He did not agree with Mr. Jennings' statement that there was no question as to the right of Government to intercept the rainfall on its own land.

Thursday, May 10th.

The President in the chair.

Messrs. Wm. Bage, W. H. Nimmo, S. C. Candler, and Arthur Dendy, M.Sc., F.L.S., were nominated as members.

The HON. LIBRARIAN announced that since the last meeting, thirty-four scientific publications had been added to the library.

The PRESIDENT announced that Mr. Lucas had resigned his position as Member of Council, owing to pressure of work. Mr. White proposed, and Professor Spencer seconded, a motion that Mr. Topp be elected to the vacant position. The motion was carried.

Mr. RUSDEN read a paper by Mr. T. Wakelin, B.A., of New Zealand, on "An experiment to show how the earth is made to gravitate towards the Sun." Mr. White remarked that Mr. Wakelin wished to go beyond the theory of gravitation.

Mr. RUSDEN read a paper by the same author, on "The Dynamical Equivalent of a Pressure."

The PRESIDENT said he thought the author failed to appreciate the true conditions of such an experiment. The results of his experiment would vary in accordance with the way in which his apparatus was made.

On the motion of Professor Spencer, seconded by Mr. Griffiths, the standing orders were suspended to allow of Mr. Dendy reading his paper on "The Anatomy of an Arenaceous Polyzoon."

The PRESIDENT congratulated Mr. Dendy on having so soon after his arrival in the colony, made an original contribution to biological science.

Mr. BRACEBRIDGE WILSON had for long known the animal without suspecting its polyzoon nature.

Professor SPENCER referred to the important work carried on by Mr. Wilson in his biological explorations in the waters of Port Phillip, in which he had discovered many new and remarkable forms.

Professor SPENCER read a paper on "The Presence of a Fluke in the Egg of the Common Fowl."

Mr. LUCAS did not quite understand how the adult fluke got into the egg.

Mr. FENTON remarked that the presence of the fluke in eggs was entirely unsuspected by the general public, and the President suggested that it would be interesting to know to what extent, if at all, it was dangerous as far as human beings were concerned.

Thursday, June 14th.

Mr. White, Vice-President, in the chair.

Mr. C. A. Topp, M.A., LL.B., F.L.S., was elected as a member of the Council.

Messrs. William Bage, Samuel C. Candler, Arthur Dendy, M.Sc., F.L.S., and William H. Nimmo were elected as members of the Society.

Professor SPENCER read a note "On the presence of a Pentastomum parasitic in the Lung of Hoplocephalus superbus."

A short discussion ensued.

Mr. ARTHUR DENDY submitted a "List of all the Species of Sponges described by H. J. Carter, Esq., F.R.S., together with a number of his more important references to the species of other authors."

Mr. ELLERY said he desired to mark his sense of the very great importance of the work to which Mr. Dendy had devoted himself.

Professor SPENCER then read a note "On the Presence of a Rare Cestode (Amphiptyches) in Callorynchus antarcticus."

Dr. NEILD reported that since the last meeting 69 scientific publications had been added to the Society.

Thursday, July 12th.

The President in the chair.

R. A. BASTOW, Esq., F.L.S., was elected a member of the Society.

The PRESIDENT introduced Sir James Hector, Chancellor of the University of New Zealand, and representative of the latter colony to the Centennial International Exhibition.

Sir JAMES HECTOR thanked the members for the welcome accorded to him.

A letter was received from Dr. McInerney stating that at a meeting of the Australian Natives' Association it had been decided that he should deliver a lecture upon Seals, and inviting members of the Royal Society to attend and speak upon the question, which had a connection with the subject of antartic exploration.

Mr. RUSDEN then read a paper for T. S. Hall, Esq., M.A., "On Two New Fossil Sponges from Sandhurst."

Sir JAMES HECTOR inquired if any researches had been carried on in the neighbourhood of Schnapper Point, since in beds similar to these in New Zealand he had discovered a beautiful specimen of Euplectella.

Mr. DENDY stated that this was the first sponge recorded in Australia from palæozoic formations.

The PRESIDENT congratulated Mr. Hall, as a student of the Melbourne University, on his interesting discovery.

Mr. DENDY then read a paper entitled "Preliminary Account of the Anatomy and Development of Stelospongus flabelliformis."

After some discussion, in which Sir James Hector, Professor Spencer, and Mr. Lucas took part, the President gave a description of the new Hawkesbury Railway Bridge.

Thursday, September 13th.

The President in the chair.

Messrs. James Ivey, Henry Shaw, John Cockburn, and A. W. Dixie were nominated as members.

The following were elected as members:—Dr. Alexander Morrison, Newton E. Jennings, Esq., J. M. Coane, Esq.

Dr. NEILD stated that the sub-librarian was working very hard in getting the library into manageable shape, and it was hoped that in the course of a few weeks a catalogue would be ready.

The PRESIDENT gave an outline of the proceedings of the Australasian Association for the Advancement of Science held in Sydney.

Professor ORME MASSON read a paper by himself and Mr. Kirkland on "Polyhaloid Salts of Organic Bases."

After some discussion, in which Messrs. Blackett, A. Sutherland, Marks, and Lucas took part, Mr. Ellery exhibited and described a new Watkin's Aneroid.

Mr. ELLERY also exhibited and described a new instrument he had devised for calibrating a particular form of pressure-gauge tester, known as the "Admiralty P.G. Tester."

Thursday, October 11th.

The President in the chair.

Messrs. James Ivey, Henry Shaw, A. W. Dixie, and John Cockburn, were elected as members.

The HON. LIBRARIAN reported the addition of 75 new publications to the library, and that the Catalogue was nearly complete.

The PRESIDENT drew the attention of the Society to the presence in the Exhibition of the first locomotive which ever ran. It was made by Murdoch and Fried, at Redruth in Cornwall. The President gave an outline of the history of the steam boat, and invited the Rev. Dr. Fraser to make a few remarks upon a model of the first steam boat built by Symington, and now exhibited to the Society.

After an interesting account by the Rev. Dr. Fraser of Symington's work,

Mr. F. A. CAMPBELL read a paper on "The Active Volcano of Tanna, New Hebrides."

A discussion ensued, in which the President, the Rev. D. Macdonald, and Professor Spencer took part.

The PRESIDENT said that before closing he must refer to the great loss that the scientific community in Melbourne had sustained in the death of Professor Andrew. He had been for five or six years Professor of Natural Philosophy at the University, and for some time before that, Lecturer in the same subject. He had been for some time in delicate health, but not dangerously ill, and had been recommended to take a trip to Europe, for the purpose of recovering his health, and of gathering ideas. He had been connected with the Society for a number of years as a Member of Council and contributor of several papers. It was, therefore, fitting that they should not allow his early demise—he was

but 44 years of age—to pass without making some mention or record of it. He was one of the earliest students in the University, having entered in 1861, and led a very successful career there. He went to Cambridge, where he was fairly successful, and afterwards occupied a teaching post at Cirencester College. Subsequently, he returned to Victoria, and was for some time head of Wesley College, and afterwards Lecturer and Professor of Natural Philosophy at Melbourne University. In Professor Andrew's death they had lost one of the most active members of the University, and one who took a great deal of interest in the Royal Society.

Thursday, November 15th.

The President in the chair.

The PRESIDENT announced the resignation of Mr. Barnard as one of the Honorary Secretaries of the Society, owing to the pressure of other duties. Professor Spencer had been requested by the Council to act in Mr. Barnard's stead, and had acceded to the request.

On the motion of Mr. G. S. Griffiths, seconded by Mr. White, Professor Spencer was elected to the vacant post.

The Society then proceeded to the election of Honorary Members, on recommendation of the Council. Dr. Agnew, Dr. Bancroft, Hon. John Forrest, Sir James Hector, Hon. W. Macleay, and Mr. H. C. Russell, were elected. Mr. E. F. J. Love, M.A., was nominated as a member, and Mr. W. Swan, as an associate of the Society.

Mr. DENDY read a "Note on some Actinian Larvæ Parasitic on a Medusa from Port Phillip."

Mr. RUSDEN read a paper by the Rev. D. Macdonald, on "The Oceanic Languages Semitic."

On the invitation of the President, the author of the paper made some further remarks, and on the proposal of Mr. White, seconded by Mr. Rusden, a vote of thanks was accorded to him.

The PRESIDENT exhibited specimens of materials which had been subjected to tests in the testing machine at the University.

Notices of re-appointment of Committees were given by Mr. White and Mr. Rusden.

Thursday, December 13th.

The President in the chair.

Mr. E. F. J. Love was elected as a member, and Mr. W. Swan as associate.

The PRESIDENT announced the names of the retiring Officers and Members of Council.

Mr. A. H. S. Lucas was nominated as a Member of Council.

The HON. LIBRARIAN'S report showed that 62 new publications had been added to the library. The catalogue had been completed.

Mr. RUSDEN gave notice of motion, for the Annual Meeting in March, of some verbal alterations in the Rules.

Professor MASSON read a paper on "The Preparation of Alkyl-sulphine and Alkyl-phosphonium Salts," by himself and Mr. J. B. Kirkland.

A discussion ensued in which Messrs. Marks, A. H. Jackson, J. B. Kirkland, Professor Masson, and the President took part.

The PRESIDENT read a letter from Mr. Culcheth, C.E., respecting the discontinuance of the publication of the Weather Chart in the daily paper. The matter was referred to Mr. Ellery.

Mr. JAMES STIRLING, F.G.S., read a paper on "The Physiography of the Western Portion of the County of Croajingolong."

A discussion ensued in which the President, Professor Spencer, Mr. Marks, and Mr. Stirling took part.

Mr. STIRLING suggested that the delegates of the Royal Society to the Australasian Association for the Advancement of Science, should advocate the sending of invitations to attend the next meeting to delegates of the principal Universities in other parts of the world. It was decided that it was better for Mr. Stirling to move in the matter in the Council of the Association.

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Main, Thomas, Esq., City Surveyor's Office, Melbourne.
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THURSDAY, MARCH 14, 1890.

SHORT ADDRESS ON THE PROGRESS IN ASTRONOMY DURING 1888–1889.

By R. L. J. ELLERY, F.R.S., F.R.A.S.

In pursuance of an arrangement made by your Council, that at our annual meeting an endeavour should be made to lay before the members a popular and brief outline of the progress in various branches of science during the past year, I have undertaken to give a short account of the principal items in the year's advance in astronomical knowledge. Although there is nothing very thrilling or remarkable to record, there are many points of considerable importance and interest, some of which we recognise as steps towards a better knowledge of the constitution of the universe and of individual parts of the solar system, as well as of the tenants of space in regions beyond.

The large number of comets that come under our observation every year now, as compared with former years, must not be regarded as evidence of the existence of a greater number than formerly, but of the fact that the heavens are now so closely scrutinised, that but few which come to perihelion, escape detection. During the year 1888, no less than six were discovered, viz. :—

(*a*)	Sawerthal's Comet,	discovered at Cape,	February 18.
(*b*)	Eucke's ,,	re-discovered,	August 3.
(*c*)	Brooks' ,,	,,	August 7.
(*d*)	Fayes' ,,	,,	August 9.
(*e*)	Barnard's ,,	Lick Observatory,	September 3.
(*f*)	Barnard's ,,	re-discovered	October 31.

The relation of comets to meteor streams is now pretty firmly established, but exactly what that relation is, still remains to be determined. Meteor streams in distant parts of their orbits have been seen as comets, but whether all comets themselves are an aggregation of meteors, or meteor streams disintegrated comets, is yet a matter for speculation. Mr. Lockyer has lately propounded a new hypothesis of the heavenly bodies, which may probably lead to new directions of enquiry, and further knowledge in this respect. His idea is that space is a plenum of meteoric particles, mostly moving in groups or swarms in regular orbits. These orbits sometimes intersect, giving rise to collision of particles, and to the formation of new and lesser orbits, and so forming a rotating agglomeration of meteoric matter, with evolution of heat and light, becoming visible as a nebula or nebulous star, and perhaps eventually as a concrete star itself. Nebulæ, comets, and nebulous stars are considered all of the same kind of matter under different conditions of motion of constituent particles, and consequently under different temperatures, as shown by spectroscopic characteristics. If Mr. Lockyer's great hypothesis be correct, we must conclude that all the heavenly bodies are made of the same stuff, under different conditions of sparseness of distribution, motion of constituent particles, and temperature. A comet, a nebula, or the planet Saturn for instance, would be of similar matter under differing conditions.

There has been a good deal written about the discovery of strange appearances in Mars, and we have read sensational articles of canals, martial inundations, &c., with all the flights of imagination of clever newspaper writers, who dress up the bare cold facts of the astronomer in a tempting garb for the popular reader. The facts are briefly as follows:— Several veteran observers with large telescopes, have recently spent much time in a continuous scrutiny of the planet Mars, during the periods of his nearest approach to the earth, and more especially at the approach in the early months of 1888. The appearances of a network of dark

lines and of changes in these lines have presented the most interesting features to the observers. These lines or "*canals*" as they are called, appear to overspread the brighter parts or continents of the planets. The markings are stated to have been seen to change under observation, the so-called canals to "germinate" or split off, leading some to the suggestion that they are actually artificial works in progress! Enormous inundations of portions of the planet's surface are also stated to have been seen. The great Lick telescope was devoted to observations of these appearances in July and August, and photos of rough drawings are on the table. There can be no doubt about the appearances, but there is about the interpretation of them. Astronomers generally, I think, are "waiting" for further developments, for there are insuperable difficulties in accepting the explanations already ventured upon. It is more than probable that all these appearances will eventually be attributed to diffraction or optical effects from conformation of vaporous surroundings of the planet, rather than of any objective change in its surface.

The great Lick telescope, the largest refracting telescope yet constructed, with an aperture of thirty-six inches, and a focal length of fifty-six feet, was first pointed to the heavens on January 3, 1888, but could not be really used till July 16th following, owing to the freezing of the hydraulic gearing. So far, I think it has proved itself, not only the biggest, but the best telescope in the world, if one can judge of its work that has been put before us, especially the drawings of some of the planets. This giant refractor, it appears, is not long to enjoy the reputation of being the largest refractor in the world, for it is now proposed to build an observatory at Los Angelos in Southern California, on Wilson's peak, 6000 feet high, which is to have a telescope of forty-two inches aperture. If this comes to pass, California will be able to boast of having the two largest refracting telescopes in the world. Speaking of telescopes, I may inform our members that the Melbourne Reflector is

still under repair, the work of repolishing the mirrors, after twenty years' work, was commenced in May last, but the preparations and practice landed us in the hot summer weather before the operation was completed, and the work had to be deferred till cooler weather prevailed, for polishing cannot be attempted so long as we are subject to temperatures of 80 to 90 and over. The work will be recommenced in about a week, and if all goes well, I hope to have the telescope at work again by May.

Preparations have been pushed on for commencing the international work of obtaining photographic charts of the heavens, if possible, during the current year, but I fear that the most than can be accomplished under the most favourable circumstances, will be "to get ready" to commence early in 1890. The photographic telescope for Melbourne is well advanced, and the building for its reception will be erected shortly. In the meantime, many improvements are being made in the methods to be adopted, and beautiful photographs have been got of faint nebulæ and other objects which have hitherto been considered "out of range" of the sensitive film.

The lunar tables hitherto used have been found insufficient, and the most recent ones, viz., those of "Hansen's," after a long period, it is found the tabular and observed places of the moon differ very considerably, showing that some disturbing causes have not been sufficiently allowed for in their construction. Some years ago, Sir George Airy (late Astronomer Royal), then over 70 years of age, undertook the development of a new lunar theory, a work of great magnitude and mathematical intricacy. In November last, he communicated to the Royal Astronomical Society, the fact that he had discovered an error which had crept into the earlier part of his work, that would necessitate attacking it from the beginning, but that with advancing years (now 88) and failing strength, he could scarcely hope to bring it to a satisfactory conclusion. It is to be hoped, however, that some others will take up this important work, so

intrepidly begun by our old Astronomer Royal in the evening of his life.

During the year, two men who had made their mark in the astronomical arena, have passed away, Richard A. Proctor, the well-known author of many astronomical works (though not a practical astronomer), and Editor of the periodical *Knowledge*, died of yellow fever in New York, on 12th September. J. C. Houzean, Honorary Director of the Royal Observatory, Brussels, author of *Uranometric Generale Vade Mecum de l'Astronomie and Bibliographic Generale de l'Astronomie,* died July 12, 1888, at the age of 68.

SHORT ADDRESS ON THE CHEMISTRY OF TO-DAY.

By Professor Orme Masson.

I fancy it will be best not to attempt to do what is impossible—to give you an account, in the ten minutes at my disposal, of the results of the chemical researches of the past year. I shall rather try to indicate some of the great problems in the science which still await solution, but towards the solution of which something has been contributed by recent important investigations.

The phrase "modern chemistry" has been used in many senses. It carries us back to 1661, or thereabouts, when we hear Boyle described as the "Father of Modern Chemistry;" to the end of last century, when Lavoisier is credited with having founded modern chemistry by his enunciation of the correct theory of combustion; and there are not wanting chemists who would make the science much younger by

dating its birth from the publication of their own text-books. From my present point of view, I would ask you to go back to the year 1863 as the date of the beginning of new things—to the year when Newlands first gave us the true principle for the classification of the elements—a principle afterwards extended by Lothar Meyer, Mendeleieff, and others, and now so well known as the Periodic Law. This is by far the grandest and most fruitful and far-reaching generalization of the past quarter century. It underlies much of the most important work of the present and of the future.

If the known elements be arranged in the order of their atomic weights, from hydrogen (1) to uranium (239), along a horizontal line, that line may be cut up into sections and these sections may be placed each below the last, in such manner that the elements which naturally resemble one another—which form a natural group—always fall in the same vertical line. To put it in another way—and a better way—we can construct a curve of which the magnitudes of the atomic weights are the abscissæ and those of any property capable of exact measurement are the ordinates; and we find that the curve, representing variation in the intensity of the property, is of a periodic character, and that similar elements occupy similar positions in the different periods.

The properties of the elements (including the properties of their compounds) are therefore functions of the atomic weights. It follows from this, that it is highly desirable that our knowledge of the atomic weights of all known elements should be as exact as possible.

The unit generally adopted as the standard for atomic weights is $H = 1$. But almost all actual determinations of atomic weights of other elements involve the previous knowledge of the value of O, or of the ratio O : H. This may be called the fundamental ratio, which underlies all others. If our knowledge of that ratio be inexact, then all deduced ratios, all our atomic weights, will be inexact in proportion, and the greater the atomic weight the greater will be the

actual error. The recognition of this fact has led, of late, to renewed attempts to determine, by experiments of the most accurate kind, the precise value of this ratio O : H. Among the workers in this field during the past year or two, may be specially mentioned Scott and Lord Rayleigh in England, Crafts in France, Keiser, Cooke and Richards in America The results of these and other experiments may be summed up in the statement that, the value $\frac{O}{H}$ is between 16·01 and 15·869 ; and that the atomic weight of uranium (where the consequent error is necessarily greatest) is between 239·76 and 237·65. We must look to the future for further light.

A glance at the table of the elements, arranged according to the periodic law, shows it is far from complete. Many of the elements whose existence is indicated by the law are not actually known to exist. They have never yet been met with. Is this from lack of knowledge merely, or do the gaps occur in Nature? When this arrangement was first made use of, it was necessary to leave gaps where now we see the names of gallium, scandium, and germanium. May we not also expect the others to be filled up in a similar manner? Here is one below manganese, between molybdenum and the palladium metals, which wants filling by an element with an atomic weight of 99 or 100 and properties that might be fairly well pre-calculated. The most recent chemical journals that have reached us here in Melbourne, contain a brief preliminary notice of some results which Professor Krüss, of Munich, claims to have obtained in an investigation of cobalt and nickel. These elements have always been rather an enigma, from the fact of their possessing, not only very closely similar properties, but an almost identical atomic weight; and our great English chemist, Crookes, has even said of them, that they might have been still regarded as one and the same element, had only their salts possessed the same colour instead of colours which are approximately complementary. Professor Krüss now claims to have resolved the old cobalt and the old nickel each into two elements, one of which is common to

the two, so that, if he can substantiate his claim, we shall have three elements—one the true cobalt, another the true nickel, and one new one. The true cobalt and the true nickel will not have the atomic weights we are accustomed to associate with those names, and an old mystery may thus be cleared up. But further, the new element will want a place in the systematic classification, and it seems to me possible—just possible—that our friend the 99 or 100 gap may now be filled. Chemists await with keen anxiety the arrival of journals with Professor Krüss' complete accounts of his work; till then, we must be cautious, even to the point of incredulity.

But, after all, shall we have arrived at the end of things when all the elements are discovered and their atomic weights and all their physical and chemical properties have been accurately determined? Is there nothing behind the elements? What is the real nature of a so-called elementary atom, and what are we to understand by the phrase "atomic weights"?

The wonderful and laborious researches of Crookes, Krüss, Nilson, and of others, on the so-called "rare earths" have led the first of these chemists (who is remarkable alike for skill in experiment, and the strength of his power of generalisation) to put forward a theory that each resting point in the periodic classification marks the existence not of one element with an absolutely fixed atomic weight, but of a cluster of *meta*-elements as he calls them, substances barely distinguishable from one another by chemical means but capable of being differentiated by the spectroscope and of being separated by methods such as fractional precipitation, and that the atomic weight of an element is really only the mean of the atomic weights of the meta-elements which compose it—numbers varying from the mean within narrow limits. His theory further takes us into a most suggestive speculation concerning the genesis of the elements and their meta-elements from one primordial form of matter, to which he has given the name of *protyle*.

Such a notion of the oneness of matter is by no means new, though there is much that is new in Crookes' special hypothesis. It is interesting to find another investigator attacking the problem of the ultimate composition of the elements from a different point of view. Within the past two years, Professor Grünwald, of Prague, has published some most remarkable papers on the spectra of hydrogen, oxygen, carbon, magnesium, and cadmium; the results of which may be summarized in his own words:—"Many, perhaps all, bodies hitherto considered as elements are compounds composed of condensation forms of the primary elements *a* and *b* of hydrogen ($H = b\,a_4$) in various physical modifications." If this be proved, Grünwald will indeed have done a great work; but we must look to the future, and meanwhile keep our minds open.

SHORT ADDRESS ON RECENT PROGRESS IN BIOLOGY.

By A. H. S. Lucas.

In the unavoidable absence of Professor Spencer at our last meeting, I was asked by the Council to report on recent progress in Biology. It has been suggested to me that I should speak on the results of the "Challenger Expedition," inasmuch as the issue of the long series of Reports has come to an end, and the office in Edinburgh is now closed; and the suggestion accords with my own inclination the more, since I shall have an opportunity at an early date of speaking on the more interesting local biological work of the year in another place.

It were easy to fill ten minutes—my allotted time—in telling of this great enterprise, but it is not easy to compress

all that ought to be said into ten minutes. The publication of the Reports can only be compared with that of the "Systema Naturæ," or of the "Régne Animal," as a great epoch-marking work in biological science.

Considered merely in a mechanical and material way, the Reports consist of some 34 thick quarto volumes. One single volume contains 1800 pages. These are illustrated by about 2000 full-size lithographic plates, several of which are coloured with precision. They record the results of critical examination of the specimens preserved in 2270 large glass jars, 1749 smaller bottles, 1860 glass tubes, 356 tin cases, and 22 casks. The cost of publication has considerably exceeded £50,000.

Biologists owe much to the descriptions of the zoological and botanical specimens collected in the course of previous voyages, undertaken for scientific purposes. Systematists have continually to refer to the accounts of the voyage of the Erebus and Terror, the Astrolabe, the Novara, the Talisman, of the Wilkes' United States Exploring Expedition; of the Beagle, the Samarang, and the Herald; of the Lightning, Porcupine, and Knight Errant, of the United States Survey Expeditions, and of others; but the Challenger Expedition is to these as Leviathan amongst fishes.

There is scarcely a group of animals which is not reported on. There are memoirs relating to Man, and memoirs on the Foraminifera and the Radiolaria. Owing to the tardiness of information from Europe, I cannot give the precise number of the memoirs, but the number is something over sixty-four. These are all contributed by men who are recognised as prominent specialists in the particular group which they have undertaken to describe.

Professor Huxley, in a review of the first volume of the Reports, did not profess to have read it through, and disclaimed the zoological omniscience which would justify him in criticising its contents in detail. No one else, then, need profess to have read all the volumes, or venture to give the palm of merit to this or that memoir. At most, one can but

mention a few of those which have perhaps more generally or more strikingly attracted attention, some from the enormous labour involved in their preparation, some from the novelty of the material described, and others from the interest of the general conclusions which have been worked out by the authors. Amongst them we may mention Professor Haeckel's magnificently illustrated monograph of the "Radiolaria;" Mr. H. B. Brady's "Foraminifera," with its revelations of the pleomorphism of the group; Dr. P. H. Carpenter's "Crinoids,' of which beautiful forms he enumerates as many as 180 species, and reports that Australasia and Malaysia are amongst the strongholds of an order which was not so very long ago supposed to be on the verge of extinction; Dr. Gunther's "Deep Sea Fishes;" the three parts of Professor Herdman's "Tunicata;" the elaborate work on the "Echinoids" and "Ophiuroids" respectively; of the American naturalists, Agassiz and Lyman; the Sponge monographs of Sollas, Schulze, Polejaeff, Ridley, and Dendy; Professor Busk's "Polyzoa," and Professor Allman's "Hydroida;" Professor Moseley's beautiful work on "Millepora" and "Heliopora," and Mr. Botting Hemsley's comprehensive studies on the "Floras of Oceanic Islands."

In many cases the writer gives a complete summary of what is known from all sources on the order of animals, of which the memoir treats. Thus, the Pteropods are completely reviewed by Professor Pelseneer, who concludes that these delicate pelagic molluscs may be ranged in a very few genera, and that the entire order should be merged in the Gastropods. Professor Allman discusses in full the classification of the Hydroida, Dr. Lyman that of the Brittle Stars, and so on. Such memoirs give the series of Reports much of the nature of an Encyclopædia Zoologica.

A bare enumeration of the authors, and the titles of their treatises, may recall the monotony of Homer's list of his heroes. I can only excuse myself by retorting that, in my opinion, the workers of the Challenger *are* heroes, and that the great Zoological Reports constitute no mean epic.

Wherever opportunity offered, full anatomical details are given, as well as zoological characters. Indeed, it is hard to decide whether anatomists or systematists will be more helped by these publications. Embryological work is naturally scanty, but Professor W. K. Parker was enabled to make out the development of a type of Chelonia, which was previously but very imperfectly known. It is interesting to note that he refers to the Leathery Turtle (*Sphargis coriacea*), which is occasionally to be met with in our Melbourne Fish Market, as the living form which best retains the indications of its ancestry.

The voyage lasted from 1873 to 1876. The first Report appeared in 1880, and the work is just completed. Eminent foreign, as well as British, scients were invited to assist, and one result has been to show that English and American biologists are able to produce work which in magnitude, in thoroughness, and in artistic beauty, can compare favourably with that of any other workers in the world.

The naturalists who accompanied the Expedition were Sir Wyville Thomson, Mr. Moseley, Dr. Willemoes Suhm, and Mr. John Murray. The credit of the general direction of the zoological work belongs to Sir Wyville Thomson. We have to regret the early death of Dr. Willemoes Suhm. Just as the voyage in the Beagle exercised great influence in shaping Charles Darwin's powers, so to that of the Challenger is due that opportunity of expansion was given to Mr. (since Prof.) Moseley and Mr. John Murray. So well-equipped were the naturalists, and so judicious and careful was their work, that I believe one may say with strict accuracy, that no material which was acquired was lost to science.

Besides adding vast numbers of new species to our lists, the Challenger gained for the world nearly all that is known of the fauna of the ocean basins, and the form under which life is maintained under the singular conditions of abyssal existence. The relations of the abyssal fauna to light, the enormous development or the abortion of the eye, the existence of remarkable phosphorescent organs, consti-

tute a new and interesting chapter in the history of living organisms.

Much light has been thrown on many more general questions. The mode of formation of barrier reefs and of atolls, the constitution of the abyssal oozes and their slow increase in depth, the nature of the red clay, the ways and means of geographical distribution, have been carefully studied, and our knowledge of them greatly extended.

Here I must close, but not without recording my pleasure that we have two Challenger workers amongst us—Dr. Wild, who accompanied the Expedition, and Mr. Dendy, who described the Monaxonid sponges. It will also, I think, be of interest to members to know that several of the specialists who wrote for the Challenger, are assisting us in the identification of the forms obtained by your Port Phillip Biological Survey Committee.

SHORT ADDRESS ON THE RECENT DEVELOPMENTS IN PUBLIC HYGIENE.

By JAMES JAMIESON, M.D.

In the limited time at my disposal, it is most desirable that I should confine my remarks on recent hygienic progress, to one or two matters of large general interest.

Perhaps no fact, in connection with modern sanitation and its results, is more striking than the great improvement which has taken place of late years in the death rate in the great towns of England. In the ten years 1871–80, the mortality averaged 24 per 1000 of the population, while in the years 1881–87 it averaged only 21·4 per 1000, and in 1887 was as low as 20·8. A remarkable contrast is to be

found in the condition of Melbourne, which, as regards sanitation, seems as if it had been entirely out of the tide of progress. In the ten years 1871–80 the death rate was 20·36 per 1000; and in the eight years 1881–88 it averaged 20·21; the rate for 1887 being 21·25, and for 1888, 20·54. It cannot be said, of course, that nothing has been done to improve the public health; but, as the results are not to be seen in the figures just given, it must be concluded that our efforts, such as they have been, have simply prevented us from suffering fully the evil effects arising from increasing density of population and its associations.

A special instance may be taken, as helping to account for the remarkable difference which we have found to exist between our own "Marvellous Melbourne" and the English towns and cities. I prefer to take typhoid fever, as being with us a perennial subject of interest. In the years 1870–1877, the death rate from fever, chiefly typhoid, in the great towns of England, averaged 6 per 10,000 of the population, while in the years 1877–1886 it had fallen to 3·2, and in 1887, to 2·2 per 10,000.

The following has been the state of things in Melbourne, at corresponding periods. In the years 1871–1878, the typhoid mortality was in the proportion of 7·8 per 10,000 of the population, and in 1881–1888 it was 7·3; the rates for the last two years, 1887 and 1888, being respectively 9·1 and 7·7. While our typhoid mortality has remained practically the same, in the English towns it has been reduced to about one-third of what it was less than twenty years ago.

There can be no doubt, I think, that the sanitary improvements which have been operative in bringing about this great reduction in the prevalence of typhoid in the English towns, have also had the chief share in lowering the general death rate. It is of no small importance, therefore, to know the cause of our failure to attain a similar result. We know more now, than we did twenty years ago, about the nature and causes of the disease, and definite rules for its prevention

have been formulated, and generally accepted as correct; and yet, from all that increase of knowledge, we seem to have received no practical benefit. The reason is to be discovered from a consideration of the causes by which the spread of typhoid is chiefly favoured. One of these is a contaminated water supply, and an interesting confirmation has lately been supplied of the belief long held about its importance. There is very satisfactory evidence that the specific germ which produces the disease, has been discovered, and this typhoid bacillus has been repeatedly discovered in water, which had been used for drinking purposes, and which had been suspected as the cause of local outbreaks. But I greatly doubt, whether this cause plays any considerable part in bring about our high typhoid mortality. The sources are now more carefully guarded than they were a few years ago; and besides, the circumstances which attend its prevalence here are not those characteristic of epidemics due to contaminated water, as they have been seen in many places. Our outbreaks are not explosive; the disease, year after year, taking a decidedly epidemic character in November or December, increasing steadily in prevalence till about March, and then declining slowly till it almost ceases in the early winter months. Our water supply is certainly better than that of most European towns, and it is not likely to be materially improved; and so, unless there is some other cause in operation, we can hardly expect to see much lowering of our death rate.

The use of contaminated milk has for a considerable time been recognised as a mode by which typhoid is communicated. It may be accidental contamination through the medium of water, which has itself been polluted with typhoid discharges, or by gross carelessness on the part of those who handle milk after having been in contact with a patient, or with soiled linen, &c., from his person. Quite recently it has been alleged that cows suffer from a form of disease, such that their milk may be capable of producing typhoid in those who drink it. It has often been alleged,

also, that from the mere fact of a cow feeding on garbage of various kinds, its milk may acquire infective properties. If there were such different ways whereby the milk of cows is rendered infective, I can hardly think that it would be so difficult to get proof of the occurrence of outbreaks due unmistakably to contaminated milk. Since the Jolimont case, about ten years ago, there has not been a single instance traced out in this City, and my own experience has compelled me to conclude that milk contamination is actually a rare mode of spreading contagion, no single instance having come under my notice during my term of service as Health Officer of the City.

It is different, I believe, with another mode by which typhoid is spread, viz., as a result of bad or defective drainage. I have often been satisfied that there was no other cause in operation adequate to account for severe and persistent local outbreaks of the disease. Evidence has actually been supplied that the typhoid bacillus may live in ordinary well or river water; and the close association often found to exist between typhoid and sewer emanations supplies a strong probability, amounting almost to certainty, that they may live, and possibly multiply, not only in cesspits, drains, and sewers, but also in soil soaked with sewage matters. The bacilli have not been found in, and would be difficult to isolate from the combination of bacterial forms which find lodgment and breeding ground in sewage matter; but if they do happen to be present there, it is almost a certainty that they would escape in the currents of foul air which rise from the outlets of town sewers. Such air does contain many bacterial forms, as has lately been proved by the investigations of Dr. J. D. Robertson (*British Medical Journal*, 15th December, 1888). He did not find on his cultivation plates the bacillus of typhoid, doubtless, as he says, because there were no epidemics at the time of his observation; but he did recognise that in sewer air there is a larger proportion of bacilli compared with other organisms, than in the open

air of streets. It appears, therefore, that sewage matters provide a good breeding ground for that particular class of micro-organisms, to which the infecting agent of typhoid belongs. Evidence of an exact and positive kind is therefore accumulating in favour of the view which, in my opinion, hardly admits of doubt that—defective drainage is the real cause of the great prevalence of typhoid in Melbourne. In that, and in our bad system of nightsoil disposal, we have insanitary conditions fully adequate to account for the great and continued prevalence of the disease, and I can see no hope of such improvement as has come about in the English towns, till we adopt their sanitary methods. It is vain to put our trust in disinfectants. The cure consists in the adoption of a system of drainage, whereby all household slops, all liquid refuse, and nightsoil with it, are swept away at once from the neighbourhood of our houses. If that were done, our scavenging would also be comparatively an easy problem. An underground system of drainage can and must be carried out, and in the saving of life and health there would be ample repayment of the cost.

There are certain diseases of animals which human beings may acquire. In addition to various forms of parasites, mention need only be made of anthrax, glanders, hydrophobia, and the familiar cow-pox, which, by the method of vaccination, has come to be looked on rather as a preventive than as in itself a disease ; but in all these cases, the spread from animal to man is either a comparatively rare accident, or at least, as in the case of vaccination, has to be deliberately produced. It can hardly be said, indeed, that we are acquainted with any disease of this general class, which spreads freely from animals to human beings by what may be called ordinary methods of contagion. In the same way, none of the general zymotic diseases which affect human beings, spread easily to the lower animals if the latter, indeed, are susceptible of contagion at all. This circumstance has made, and will make, it difficult to obtain

conclusive evidence that such diseases as cholera, typhoid, small-pox, and measles owe their origin to living germs, the final test being that the germs, when cultivated pure, are capable, by inoculation or otherwise, of again producing the disease. Till quite recently, this want of relation with any disease of animals was held to be notably the case with scarlet fever. The chief mode by which it spreads, as an epidemic, is undoubtedly by way of direct or indirect contagion from person to person.

There have been a few instances, generally accepted as well authenticated, in which the contagion seemed to be conveyed through the medium of milk. But it was always taken for granted, even when it was not clearly proved, that the milk had become contaminated by access to it of scales from the skin, or other infecting particles from the body, of a patient suffering from the disease. It came, therefore, as a startling novelty, when, in 1886 it was announced, on good authority, that an outbreak of scarlet fever in a district of London, had not only been traced to the use of milk, but that this milk got its contagious properties, not by contamination with particles from a scarlatina patient, but by the circumstance that it was derived from diseased cows. Experiments were made by Dr. Klein, the well-known bacteriologist and microscopist, and the circumstances and surroundings of the dairy were carefully inquired into by Dr. Power, one of the most experienced Inspectors of the Local Government Board. The cows were found to be suffering, not only from general signs of illness, but from a disease affecting the udder and teats. From the sores on these parts, Dr. Klein obtained bacterial forms, which he declared to be similar to those which he also found in the bodies of scarlet fever patients. He further made pure cultures of the special organism from both sources, and by inoculation on calves, produced a form of illness, which resembled in different respects, both the scarlatina of man and the disease from which the cows had suffered. On inquiry, it did not appear that there were cases of scarlatina

at or near the dairy, from which contamination of milk in the way usually accepted, could have taken place. Dr. Buchanan, the head of the Medical Department under the Privy Council, accepted the evidence as conclusive, the medical world was taken by storm, and the "Hendon cow disease" was everywhere talked of as the clearly established source of an outbreak of milk scarlatina. It seemed proper that the veterinary authorities should make an independent inquiry, and the services of Professor Crookshank, a recognised authority on questions of bacteriology, were engaged. In the reports which have since been issued, it is stated that the so-called Hendon disease is well known to cow keepers and veterinary surgeons, who describe it as cow-pox, and the experiments made by Professor Crookshank were considered by him to establish this belief. It was further stated that there had been scarlet fever in a house not very far from the dairy, and that there had been constant communication between the two places. The very remarkable fact further came out, that though the milk was considered to have caused scarlet fever among persons living in London, it had no such effect among the persons living at or near the dairy, who regularly consumed it.

It was further stated that, in two adjacent dairies, the cows suffered from a similar disease to those at Hendon, but that there was never any suspicion that the milk from these had caused scarlet fever. So the question at present stands, after a good deal of heated controversy; and on a review of the whole evidence, it seems as if Drs. Klein and Power had been somewhat hasty in coming to conclusions, and the latest reports of outbreaks of scarlet fever, occurring more or less in coincidence with the occurrence of signs of illness among the cows supplying milk, are by no means conclusive. The question has great practical, as well as theoretical interest; for if such a dangerous disease as scarlet fever may be produced by the milk of cows suffering from some kind of disease, it is of the utmost importance that the nature and symptoms of that disease should be clearly defined, in order

that precautions may be taken. Its identification, too, might lead to important results, by bringing nearer the probability of attaining some system of prevention analogous to vaccination against small-pox. But another very important point is also raised. If scarlatina can actually be produced in this way, it will be necessary to go back and review the evidence, as to the mode of production of former milk epidemics. Were they really due, as supposed, to contamination of the milk with infecting particles from a scarlet fever patient? In that way, indeed, the whole question of the spread of disease by means of contaminated milk is again brought up for open discussion. The effect has been to call forth a quantity of evidence in opposition to the view that scarlatina is readily produced by contaminated milk. In the "Report on Eruptive Diseases of the Teats and Udders in Cows," recently issued by the Agricultural Department, there is given in an appendix a report by Dr. Hime, on his observations in Bradford during a very severe epidemic of scarlet fever in 1887. He narrates a number of instances of scarlet fever occurring among children living at dairies, and yet among the families supplied there was almost complete immunity from the disease. He had also occasion to inquire into the cause of outbreaks occurring among the customers of particular milksellers, without being able in any instance to discover that the suspicion which had fallen on the dairy was in any way well founded. His conclusion was that if, under conditions so favourable to the spread of infection, it did not occur, it is more than probable that there must be the greatest difficulty in milk becoming infected.

At a meeting of the Epidemiological Society of London in December last, a paper was read by Dr. Shirley Murphy, on "The Sanitary Administration of Dairy Farms." His object was to point out the need of legislation, to guard against the spread of disease among dairy cows, and against the infection of milk. Referring to the risk of milk becoming contaminated by particles from scarlet fever

patients, he gave his experience of a public institution, in which the milk was for years exposed daily to the risk of infection, by being carried through wards containing scarlet fever patients, without any appreciable effect upon persons who afterwards drank it. The milk was sometimes even further in danger of being contaminated by being served out by a woman who was actually attending on the patients, and yet it did not produce the disease. All this, of course, is only negative evidence, and Dr. Murphy's object was not so much to oppose the doctrine, that milk thus contaminated may cause scarlatina, as to enforce the need of careful examination of the cows themselves, whenever milk is suspected of being the medium of conveying infection. Under any circumstances, nothing but benefit to the public health can result from full inquiry into all such disputed questions. The whole matter shows further, how necessary it is to keep ourselves open to the influence of fresh knowledge, and be ready, if necessary, to amend even what we had come to look on as settled doctrines.

As regards the two diseases to which I have referred, the main points about their infectivity and mode of spread, remain untouched. In connection with typhoid, we have to guard against impure water supply and insanitary surroundings; and in the case of scarlet fever, we must trust to isolation and disinfection, on account of the intense contagiousness of the disease.

SHORT ADDRESS ON GEOLOGICAL PROGRESS.

By G. S. Griffiths, F.G.S.

The past year has been marked by no special feature as far as Australian Geology is concerned. The geological staffs of the various Colonies have continued to extend their surveys, whilst private observers have added to our knowledge of the interior and other parts. Mr. Jack's discovery of cretaceous fossils in the lower beds of the desert sandstone of Western Queensland—confirmed as the age of these has since been by Professor Tait, after an examination of the fossils—is an event of great importance. The chalk beds of the coasts of Victoria and South Australia, between Portland Bay and the Murray mouth, have been further investigated, and the fossils collected by Mr. Dennant and others have led Professor Tait to remove the lower stratum from the Miocene, to which the Rev. Julian Woods had assigned it, into the Eocene. In New South Wales, the finding of a well-preserved labyrinthodont at Biloela, enables Professor Stephens to confirm the Triassic age of the Hawksbury sandstone. Some very interesting remains of ganoid fishes have been unearthed near Mansfield by Mr. G. Sweet, who will shortly publish particulars of this Old Red Sandstone deposit. In Western Australia the carboniferous area on the coast is receiving attention, and Mr. R. M. Johnson, of Tasmania, is preparing a comprehensive work upon the geology of that island.

To turn from local developments to the recent history of the science in Europe, I notice that an important Congress of Geologists has been discussing the principles of geological map making, with a view to unify practice in relation to coloration and symbols, and to simplify the terminology. These objects must have our entire sympathy, and if they can be secured, the study of the science will be distinctly asssisted.

The important branch of Vulcanology has made an invaluable addition to its literature, with the publication, by the Royal Society of Great Britain, of the report of its Committee upon the Krakatoa eruption. That body comes to the conclusion, that the extrusion of the volcanic matter of an eruption is due, not to the presence of water in the magma, but to the occlusion of potentially gaseous compounds, formed by chemical interaction between some of the heated minerals. This important generalisation has been dubbed the "Cartridge theory," as it pre-supposes that there are in the crust of the globe certain strata which, being heated, generate within themselves explosive gases, which thereupon rend the overlying rocks, and then by their expansion, expel the molten magma in which they are entangled. According to this view, the paroxysmal outbursts which so frequently mark volcanic emissions, are due to the accidental admission to the lava of quarry water, which nearly always saturates all the rocks forming the walls of the upper part of the rent.

Another subject which was discussed at the recent Geological Congress, is the nature and origin of the crystalline schists. Whilst a great diversity of opinion prevailed between the greatest living geological authorities, in relation to many important but open questions bearing upon this class of rock, the tendency of the discussions reveals a widely held belief that the schistose characteristics of gneiss have been developed by the dynamic strains incidental to the process of mountain building; and also, that any kind of rock subjected to this intense pressure may be transformed into gneiss, whether it be of sedimentary, organic, or plutonic origin.

These matters are the principal points which come under notice in reviewing the geological progress made during the past year.

SHORT ADDRESS ON LITERATURE AND THE FINE ARTS.

By JAMES EDWARD NEILD, M.D.

The title of this short paper is comprehensive, and there is very much more to be said thereon than can be compressed in the ten minutes allotted to me; but as I have an end to serve, namely, the formulation of a section not as yet formulated, and as my purpose can be achieved as easily in ten minutes as in two hours, I accept the limitation. I will not attempt a history of the subject, even in epitome. I will not even try to describe what has recently been done in the domain of Literature and Art, for even within these confines it would be impossible to set forth, even categorically, what has of late been accomplished in the direction of books, pictures statues, and buildings. I will be provincial, and I will use only so much of the limited material at my command, as to draw attention to the much-regretted neglect by the Royal Society, of Section G, which, as you know, takes in Literature and the Fine Arts, including Architecture. And considering that the first clause of the Laws of the Society declares that the institution was founded for the advancement of Science, Literature, and Art, it is at least remarkable, that hitherto, the operations of the Society have been almost exclusively confined to the consideration of the first of these subjects.

In Law 38, it will be observed, provision is made for [illegible] work, this being defined in an enumeration [illegible] sections, all of them, however, curiously enough, [illegible] to Science, except Section G, which, as I [illegible] deals with "Literature and the Fine Arts, [illegible] Architecture." I am quite sure it is not because [illegible] have been considered of subordinate import-

ance that they have not been dealt with, neither has it been supposed, I think, that in a new country such as this, the *belles lettres* are incongruous or premature. It is possible that it may have been deemed unnecessary to take them into consideration, in the belief that societies exist here, having a special mission to concern themselves with Art and Literature. In any case, it is a cause of regret that Section G has, up to the present, never been developed. I should very much like, therefore, to assist in developing Section G.

I am aware that it has been asserted, sometimes regretfully, sometimes scornfully, that we have no Australian literature other than periodical literature, and that periodical literature comprises newspapers and very little else. It is true we do not produce many books, and it is not less true that of the books we do produce, some of them are not worth keeping. But after you have well sifted all the books which all the colonies have given to the Australian world, there will remain a residuum which, small as it is, represents a literature of its own kind. Among the many writers of verse, there have been some poets; among the numerous story-tellers, there have been a few whose tales are worth preserving; there are historians whose records it would be a calamity to lose, and we have had essayists whose writings deserve to become classical. In respect of dramatic writing, we have not achieved much distinction. In part proof of this, I may mention that, during the last twenty-five years, I have read about 300 plays in manuscript, and I am obliged to say that I could not recommend more than five of these to the consideration of managers, and even this recommendation was hesitatingly conceded. The bulk of our Australian literature, therefore, is periodical; that is to say, it consists of newspapers; and of this kind of literature, we have a good deal. I have to admit that a large proportion of it is of a superior kind, and that some of it is of a high-class character. I am not unaware that another proportion of it is of an opposite degree of excellence. I am not now speaking, nor need I be expected to speak, of the moral tone of Australian

newspapers, but only of their literary quality; and, basing my assertion upon a good deal of experience, I say with confidence, that the literary quality of the newspapers, in Victoria at any rate, is, with exceptions of course, of a kind upon which we may congratulate ourselves. Whatever literary feeling there may be in Victorian society, therefore, is to a large extent derived from, and is built upon, the newspapers. We have proportionally a much larger number of newspapers than they have in the old country. There are hundreds of towns in England, of considerable size, that have no public journal whatever; whereas in this colony, the very smallest township has some kind of newspaper. There is thus an extensive diffusion of information, and every member of the community is indebted to the newspaper for a great deal of the knowledge he possesses.

But we also import books in great numbers from the old countries of the world, and it is by no means exceptional, nowadays, for persons of even moderate means to possess libraries often of considerable size. It is true that not a few persons of means that are much more than moderate, have no libraries at all, and that of those who have them, some never read them. The story is extant of a gentleman, belonging to the extremely wealthy lower orders, who, having been persuaded to include in the plan of a new house he was building a library, ordered his books from England by the ton. He said it simplified matters to send for two tons. I myself have been in houses where the decorator had carte blanche given him, but in which the library did not number more than fifty volumes.

For all this we are, by comparison, a reading people, and as far as reading may induce the literary faculty, a writing people. The letters that from time to time appear in the newspapers, may be accepted in demonstration of this latter proposition; and they probably do not represent more than a tithe of those actually written. I am not going to say that all such letters indicate marked literary skill, but they certainly represent a good deal of such skill, and some of

them are veritable essays, not unworthy the trouble of preserving. It would be untrue to say, that a newspaper-reading people is of necessity a literary community. The Americans, as we all know, have more newspapers in proportion to population than any other nation in the world, but as a people, they cannot certainly be regarded as literary, and they themselves have confessed that they are not an educated people. I justify this statement by reminding you that a not undeservedly popular lecturer from the United States, who visited these colonies only a few years since, told us that 5,000,000 of the 50,000,000 of the great republic, over ten years of age, could not even read; that 6,250,000 could not write; that of the 10,000,000 of voters in the States, one in five could not write his name; that of the 10,000,000 of children enrolled in the public schools, 7,500,000 were in absolute ignorance of the English alphabet. He further said that in 34 cities, from 50 to 84 per cent. of the children were not enrolled in schools at all; that in 86 cities, the average attendance at school was only $\frac{2}{3}$ of the enrolment; that in New York, 200,000 children had never been to school at all; that in Chicago only a third of the children went to school; and that in St. Louis, out of a population of 106,000 persons, 50,000 were growing up literally savages. These particulars were offered only as samples of the literary destitution there prevailing, and they were supplied by an American. Now in Victoria, according to the last completed Year Book, nearly 95 per cent. of the children at the school age were being educated either at state or private schools.

It does not follow, of course, that education as we know it, confers the literary faculty, but at least it supplies a ground work for a beginning. We may claim, therefore, that as we have here educational facilities if not superior to those of other states, yet equal to most of those who are best supplied, we ought to be a literary community.

The misfortune is, that many who enter upon a literary career, appear to think that the calling requires no special

training. It is not objected that the calling is taken up in supplement of other callings, but because it is not the principal avocation, it seems as if it were regarded as unnecessary to study the art of literary composition systematically.

A well-known epigrammatist has said, that it requires five years to learn to be a cabinet-maker, but that one may become an author in half an hour. The reply to this was, that it was witty, but false, for that a literary man has to undergo a long apprenticeship. His school-life, his college-life, his travels, his hearing, seeing, reading, observing, suffering, all are parts of his training. Then with all this training, he has often to work at labour he does not love, and his writing has to be done furtively, or in the intervals of his enforced daily work.

Going back for historic examples, we find that Hesiod was an agriculturist, Thucydides a general, Xenophon a commander, Plato and Aristotle schoolmasters. Cicero morever, was a politician, Varro a soldier, Horace first a soldier, then a secretary. And to come nearer to our own times, La Rochefoucauld was a courtier, Montesquieu a judge, Chateaubriand a sub-lieutenant, and Balzac a reader of proofs. And then, as we know, Shakspeare was an actor, Byron a lord, Grote a banker, Dickens a reporter, Cooper a consul, Bancroft a minister, Emerson a pastor, and Oliver Wendell Holmes is a physician. I suppose no man, nor no woman, ever set out upon the journey of life, with the set purpose of being an author, and yet an author, worthy of the name, requires a training harder a great deal than that needed for any other vocation.

Professor Huxley recently said, "I fancy we are the only nation in the world who seem to think that composition comes by nature. The French attend to their own language, the Germans study their's, but Englishmen do not seem to think it worth their while." As Dogberry has it, so they apparently think that "reading and writing come by nature."

It is a melancholy thing, however, when a consciousness of the writing faculty prompts the possessor, he not being a poet, to make verses. Christopher North, it will be remembered by those who are familiar with his now not much read, but undeservedly neglected works, especially the *Noctes Ambrosianæ*, begins one of his reviews with this epigrammatic declaration—"All men, women, and children, are poets, except those who write verses." And at a somewhat later period, it will be remembered that Carlyle wrote, in acknowledgment of a sonnet he had received from his friend, Dr. W. C. Bennett, as follows:—"Your name, hitherto, is known to me chiefly as associated with verse. It is one of my constant regrets, in this generation, that men to whom the gods have given a genius, which means a light of intelligence, of courage and all manfulness, or else means nothing, will insist in such an earnest time as ours has grown, in bringing out their divine gift in the shape of verse, which now no man reads entirely in earnest. That a man has to bring out his gift in words of any kind, and not in silent divine actions, which alone are fit to express it well, seems to me a great misfortune for him; but that he should select verse with its half credibilities and other sad accompaniments, when he might have prose and be wholly credible, if he desired it, this I lay at the door of our Spiritual teachers (pedants mostly, and speaking an obsolete dialect), who thereby incalculably rot the world, making him who might have been a soldier and fighter (so terribly wanted just at present), a mere preacher and idle singer. This is a fixed perception of mine, growing ever more fixed these many years; and I offer it to you as I have done to many others in the like case, not much hoping that you will believe in it at once. But certainly a good, wise, earnest, piece in prose from you, would please me better than the musicalest verses could."

God forbid that I should discourage the true poet from scattering his pearls upon the earth. A genuine poet is a creature to be worshipped, but although there may be only

one real poet in a million of men, there may be many eloquent writers who are no poets; and of these, I am sure there is a large quota in Victoria. I should like to gather some of them together under Section G.

Then of the "Fine Arts, including Architecture." Concerning this latter, if I were to say all I think at this moment, I should make every Victorian architect my deadly enemy, for this Marvellous Melbourne, in my judgment, is only a large collection of architectural eyesores. It is an ocean of ugliness, with a very few small islets of beauty; a wilderness of brick and stucco, with here and there an oasis of honest masonry.

Of sculpture we have not much, and this little is chiefly imported. The examples at the National Gallery are many of them melancholy illustrations of probably good intention, but disastrous ill-judgment on the part of the buyer. I except the majority of the casts, especially from the antique. It is the marbles, for the most part, that make me sad. The latest of these illustrations of imperfect judgment in the selection is *The Bull and the Herdsman* by Boehm. The sculptor of this work, R.A. though he be, furnishes, I think, another instance of misdirected talent. It is especially the purpose of sculpture, I take it, to elevate, to refine, to exalt the mind above gross surroundings. And I do not think a bull and a bull-keeper suggest any thoughts that are elevated, refined, or exalted. The workmanship of this piece of statuary is excellent, no doubt. The thing is as like a bull as it is possible to make it in marble, but I will not believe that excellence of technical handicraft represents the highest condition of art. A turnip, a pumpkin, a mangel-wurzel, a stump of a tree, a sack of potatoes, a wheelbarrow, might all be carved in marble, and they might demand from the sculptor great manipulative skill, but what then? They would still be severally turnips, pumpkins, mangel-wurzels, tree-stumps, potato-sacks, and wheelbarrows. They would lead you up to nothing higher than themselves; and so of this marble bull. Such a work would be appropriate enough for a tavern sign, or as the centre-piece of an

agricultural hall; or a successful grazier might have it erected in his front garden, but it is only a perplexing incongruity where now it stands. It may help to teach a mere stone cutter, but not a sculptor.

We have a gallery of pictures, and some of them might well enough remain where they are, both to please the public and to instruct the students; others might be removed to a separate gallery, and kept as examples to show the students what to avoid. And, indeed, it would do a great many people, other than students, good to be taught what kind of pictures they should not hang up in their houses. In the dwelling-places of even well-informed people are to be found literally chambers of pictorial horrors, and yet they excite no distress in the minds of the possessors, because these ill-advised, although possibly inoffensive, persons do not know what a picture worthy of the name of picture is. But another class of people are even worse than these, for they suffer from a form of pictorial blindness, and variously paint, or buy, pictures which make a healthy-minded man shudder at the sight of them. We had some of these morbid specimens in the Grosvenor Gallery when it was with us twelve months ago, and I am afraid they did harm by demoralising the feeble art principles of divers invertebrate persons, who are much swayed by authority, and incapable of thinking for themselves. Happily, we have in Mr. Folingsby now a whole-souled, healthy-minded director of our art school, and the students he from time to time turns out are similarly whole-souled and healthy-minded too. They paint honest pictures, every one of which has a meaning, and sets you thinking of their meaning, an effect which every good picture is capable of doing. I do not think our art students are likely to be ever corrupted into the heresy of painting "Scapegoats," or "Triumphs of Innocents."

But Mr. Folingsby's good teaching should be extended, and made a more general use of. No doubt there are some good drawing masters in Victoria, but judging by such examples as I very often see, the drawing masters themselves

cannot draw. And as to teaching the principles of pictorial art, it is practically unthought of. For besides technical skill, a student should, I think, be instructed how to distinguish between what is essentially picturesque, and what is not.

Sala some years ago said, "He who can draw, be it ever so badly, has a dozen extra preference shares in every landscape, shares that are perpetually paying golden dividends. He can not only see the fields and mountains, the rivers and brooks, but he can eat and drink them. The flowers are a continual feast, and when the rain is on them, and after that the sun, they may be washed down with richest wines. To the artistic eye, there are inexhaustible pleasures to be found in the meanest objects. There are rich studies of colour in a brick wall; of form in every hedge and stunted pollard; of light and shade in every heap of stones on the macadamised road; of more than pre-Raffaelite stippling and finish in every tuft of herbage and wild flower. The shadow cast by a pigstye on a road; by an omnibus driver's reins on his horses' backs; the picturesque form of a donkey-cart; the rags of a travelling tinker; the drapery-folds in a petticoat hung out to dry on a clothes line in the back yard; the rugged angularities of the lumps of coal in the grate; the sharp light upon the decanters at home—all these are fruitful themes for musing and speculative pleasure. The fisherman who can draw, has ten times more enjoyment in his meditative pursuit, than the inartistic angler. An acquaintance with art, takes roods, perches, furlongs from the journey; for however hard the ground may be, however dreary the tract of country through which we journey, though our twenty miles may lie in the whole distance between dead walls, have we not always that giant scrap book the sky above us—the sky with all its varieties of colour, its rainy fringes, its changing forms and aspects? I would not have a man look upon the heavens in a purely paint-pot spirit; I would not have him consider every sky as merely so much Naples-yellow, crimson-lake, and cobalt-blue, with

flake-white clouds spattered over it by a dexterous movement of the palette knife; but I would have him bring an artist's eye, and an artist's mind to the heavens above."

Moreover, I would have students taught the reason why one class of lines, or forms, or colours, gratifies the eye more than another. Max Muller some time ago explained anatomically the reason of the universal admiration bestowed upon curves instead of straight lines. He told us, that the eye is moved in its orbit by six (*i.e.*, the four recti and the two oblique) muscles, of which four (the recti) are respectively employed to raise, depress, turn to the right, and to the left. The other two (the oblique) have an action contrary to each other, and roll the eye on its axis, or from the outside downward, and inside upward. When therefore an object is presented for inspection, the first act is that of circumvision on going round the boundary lines, so as to bring consecutively every individual portion of the circumference upon the most delicate and sensitive portion of the retina. Now, if figures bounded by straight lines be presented for inspection, it is obvious that but two of these muscles can be called into action, and it is equally evident that in curves of a circle or ellipse, all must alternately be brought into action; the effect then is, that if only two be employed, as in rectilinear figures, those two have an undue share of labour, and by repeating the experiment frequently, as we do in childhood, the notion of tedium is instilled, a distaste for straight lines is gradually formed, and we are led to prefer those curves which supply a more general and equable share of work to the muscles. This explanation, it will be seen, happily introduces science into the province of art, and there can be no question, that both high art and pure literature may occasionally profit by invoking aid from Science.

The drawing taught in our State Schools, and in the so-called Schools of Design, if we may judge by the work of the pupils occasionally exhibited, is of a very mechanical kind. The examples, for the most part, show neither taste, feeling, originality, nor technical facility. No art principles

appear to be inculcated, no obligation is enforced of the pupil thinking for himself. It is a neglect of this kind that I hope will be pointed out by means of this section, and in this way we may aid, not inconsiderably, in the general scheme of State education; a scheme which in particulars, other than those of art-knowledge, is greatly in need of amendment.

PROCEEDINGS.

great interest to be forgotten; and, in the beginning of last year, at the instance of Professor McCoy and Mr. Murray, the Secretary for Mines, Mr. C. W. Langtree, provided funds for a further investigation.

The Rev. A. W. Cresswell accordingly visited the district. He spent a day or two or there, and searched along the Broken River, near its junction with the Bridge Creek, and some distance up the latter. He found some interesting fossils himself, and left two men under the supervision of Mr. P. Bromfield, the Shire Secretary, with directions to excavate for more*, with the result thus summed up by Professor McCoy:—The Rev. A. Cresswell procured some "scales" allied to those of *Glyptolepis* in appearance; and examples of still greater interest of Acanthodian fishes related to known Old Red Sandstones types. He also brought various examples of the *Lepidodendron mansfieldense* (McCoy), of which lithographic figures have been prepared for the Decades of Palæontology of Victoria, with all the details necessary for a satisfactory recognition of the species, which is quite distinct from the *Lepidodendron australe* (McCoy)† of the Avon River, Gippsland. Yet these were, except in the case of the *Lepidodendron* just referred to and an Acanthodian fish and one or two others, so fragmentary that determination was both difficult and hazardous.

Mr. Cresswell was, however, unable to spare time for further work in the field, and Professor McCoy did me the honour to suggest that I should undertake a more thorough examination of the rocks of that locality. The Secretary of the Mining Department, Mr. Langtree, promised to render every assistance, and to supply a limited sum to employ men to quarry. As I feel great interest in the ancient forms of life, and possess a certain amount of ambition to assist in obtaining more complete knowledge of the remains which are at present hidden in the rocks on this side of the globe, I consented to undertake the work. We left Melbourne on the eighteenth of December last, at which date only, the services of Mr. James Tolmie could be secured as guide, and reached Mansfield on the nineteenth.

The first characteristic purplish red sandstone rock makes its appearance on the roadways, having been used for repairing them, shortly after leaving the highly-inclined

* Memorandum of Rev. A. W. Cresswell, M.A.

† Memorandum of Professor McCoy, C.M.G.

Upper Silurian strata of Maindample and Doon. Reaching an elevation in the track near the Paps (a considerable hill to our right, terminating in two peaks), other striking features of this district come into view; its beautiful park-like character, well grassed and thinly timbered, with fair sized red gums; while beyond, the distant hills, with their slightly inclined strata and almost horizontal tops, can be plainly seen. Mount Timber Top is seen straight before us some distance away. Slightly to the left, and apparently near by Mansfield, but proving on closer acquaintance to be a mile or two distant from the township, is the conspicuous Battery Hill, called by way of compliment Mount Battery; while farther back, and more to the left and north, range in apparently close proximity the Wombat, Table Top, and Hat Hill, all more or less conspicuous from their almost horizontal tops, and occasional long lines of shelf-like projecting rocks. These attract more and more attention till we reach Mansfield. From the township, a walk of a few minutes only brings us to Ford's Creek, on the Benalla Road, where we are face to face with broad surfaces of flat sandstone rock, many yards in width, visible for a considerable distance in its bed. To the north-east, at a short distance, is the Mount Battery, whence the fossil plants came which attracted the attention of Mr. Selwyn. In a northerly direction, to the summit of the Wombat, Timber Top, and Hat Hill, attaining an altitude of from 2000 to 3000 feet, every creek, cutting, or protruding rock exhibits hard gritty flagstones of reddish brown to purplish red, with chocolate and claret coloured fine grained sandstones (some having a micaceous character), interstratified with very thick beds of rubbly shale and mudstone, resembling rocks I have seen at the Iguana Creek, and the Avon River in Gippsland.

Examining the formation along the Broken River, from the old bridge at Dueran to the spot searched by Mr. Cresswell, and on to Mr. P. O'Halloran's selection, and into the enclosure known as the Tannery Paddock, being part of what is now Mr. Mitchell's Dueran Estate, I found them composed of chocolate coloured rubbly shales changing to a purplish tint, interstratified with beds of much harder material, showing in places ripple and other markings. Having reached the spot shown to me by Mr. James Tolmie, where he found the fragment of *Ichthyodorulite*, resembling *Gyracanthus*, I ascertained them all to have been found as freestones, and not *in situ*.

The Broken River, for a considerable distance in this neighbourhood, runs approximately from east to west, while the strata dip at an angle of from 4° to 8° to the south-west, the general inclination of the land surface on the north, as of the strata, from the tops of the Hat Hill, Table Top, &c., six miles distant, except where denuded and scooped out to form the deep valleys which can often be observed, is toward the river.

The western boundary of these rocks, north of the Broken River, is approximately along the line of the Blue Range Creek, where they abut on, and appear to overlap, the granite rocks which culminate in the Blue Ranges.

The strata on the south side of the river continue to dip, wherever seen, in the same direction, and at about the same angle as on the north side. The land surface generally, however, rises slowly from the river for a few miles, till it reaches the watershed of the Delatite River and its tributaries, not, however, without an occasional hill, evidently the remains of an extensive and almost horizontal area, which the denuding agency of the receding waters failed to remove. By far the most conspicuous of such, is the Battery Hill before referred to, and several others on the north of Broken River, including the Hat Hill, Table Top, &c. The small hill, also on the north of the Broken River, and to the west of Bridge Creek, visited by Mr. Cresswell, is one example; and the somewhat larger hill, a mile further east, close to the river, forming a part of Mr. P. O'Halloran's and Mr. Mitchell's properties, and containing an area of about one hundred and twenty acres, is another. It is with these two last-named elevations, and chiefly the latter, that this paper is concerned, as it was this place which appeared to me to present the greatest facilities for ascertaining the succession of the various strata, and obtaining fossils.

Our camp was fixed at 11 (Plate 1) on the south side of the river, so as to be near at hand. The wisdom of this was soon apparent, as we were thus enabled to use all available daylight for our work. For though the employés worked but eight hours per day, my investigations occupied me nearly double that time, daylight being supplemented by the lamp, for some of the work that had to be done.

If we start from the point at which the line Y Y bisects the hill on its western side, the site of No. 1 in sketch, indicating the first excavation, and look south-west, we at once notice a steep embankment, which slopes some thirty

feet down to the river flats below, and forming the upper ledge of this embankment, and immediately below the surface, a band of hard rock four feet in thickness, which has served to protect the underlying beds from denudation, and has thus played an important part in determining the present conformation of the hill. Looking north-east, the hill rises before us in a plane, closely parallel to the plane of stratification of this band. If we now walk along the embankment with the hill on our left, we gradually come down to the level of the river, and obtain evidences of its action. Some of the rocks have been undermined by the flood waters, and stand out in bold projections; others lie with their upper surface exposed in large flags, which occasionally show ripple-markings, and an innumerable number of what seem to be fucoids or the castings of worms. As we come round the hill, and approach the point, No. 9, where the line Z Z^{11} crosses the river, the rocks form its bed for a short reach, and pass out of sight on the other side. Beds, superior to any now remaining on this hill, have been revealed by the flood waters on the other side of the river; while a little to the east of this line, clear evidence exists that the river has cut for itself a considerable depth and width through the hard rocks into the softer rubbly shale or mudstone.

The general appearance of the locality favours the view, that at no very distant period of time the flats above this point were occupied by the waters of a lake, extending over the Tannery Paddock and beyond. These flats are in winter almost a swamp, and where it is cut by the river, I found that the alluvial deposits attain a depth of some twenty feet. The erosion of the hard rocks at this lower extremity has, I think, drained the lake.

Continuing on the north side of the river, along the embankment, which now becomes more steep with the projecting rocks shelving out, several lower beds show themselves along the escarpment, marked No. 8. A short distance from here, the embankment ceases to be precipitous, and slopes out a long way to the flats. On reaching the point marked Z^{11}, the aneroid indicated one hundred and forty feet above the river. Hence, to the point of commencement, the north sides of this isolated remnant of what was once an extensive plateau, stretch away to the lower land. A survey of the country around, from the highest part of this hill, gives evidence of its former continuity with several other elevations

on the north of the river. The sloping surfaces of the hills are seen to be nearly in one plane, including that visited by Mr. Cresswell, to the west, and the Hat Hill. It reveals also the chief cause of their isolation, which is clearly the extensive denudation which has taken place during the slow elevation of the land through the waters, intensified by more recent causes. The action referred to has removed the rock for a depth of one hundred and thirty feet from the top of this hill (marked Z^{11} on sketch) to the flats below, exposing a series of twenty-four beds of varying thickness.

As will be observed from the specimens exhibited, the prevailing rock of the north-east of this declivity of the hill is a rubbly and nodular shale or mudstone, of chocolate, claret, or purplish-red, and in one or two cases of a pale green and greenish-blue colour, so much so, that of the twenty-four beds of rock, thirteen, having an aggregate thickness of one hundred and fifty-two feet, are of this character, interstratified with eleven beds of different rocks.

These eleven contain a thickness of only eight feet six inches, giving a total thickness of beds of all kinds of one hundred and sixty feet, but which, owing to the inclination of the beds, and the five upper beds not being found till the summit of the hill is passed, gives but one hundred and thirty feet as the altitude of the hill above the river flats.

Let me now direct attention to the various strata, their general character, and the fossils found in each, beginning at the lowest stratum observed, at the north-east of the hill indicated by Z^{1} on the line $Z\ Z^{11}\ Z^{1}$.

The lowest member of the series observed (Plate 2, A) was a dull red dense micaceous sandstone. In this, no fossil remains were detected, and the lower limit was not seen, but a few feet being exposed. Resting on this is a bed, thirty feet thick, of the dull purplish, rubbly, nodular, and calcareous shale or mudstone before referred to. Next, we reach six feet (B) of a bluish-green calcareous mudstone shale, slightly micaceous, and retaining the rubbly and nodular character of the thirty feet bed of mudstone rock on which it rests. Then follow fifteen feet (C) of rock similar to A, bearing on it one foot (D) similar to B, and then another fifteen feet (E) similar to A. We now reach a six inch stratum (F) of much harder rock, which has resisted the action of the weather more than any of those named, and projects out in a long yellow line. This, when broken into, displays a bluish-grey arenaceous limestone, slightly micaceous, chang-

ing to light yellowish-brown on exposure and loss of lime. No. 5 excavation was on this bed.* Then twenty feet of rock (G) similar to A, are met with. We now reach a most interesting bed (H) (excavation No. 4) about nine inches in thickness, of calcareous and micaceous sandstone, of varying colour; the prevailing rock being of a dense, dark, bluish-grey, having lenticular patches, some of a yellowish, and others of a green tint.

Material similar to the lower bed A was then passed through in bed I for twenty feet.

J is a six-inch bed of brecciated fine-grained calcareous sandstone, resisting the action of the weather, and ledging out, having a very mottled appearance.

K is eight feet of similar rock to A.

L is a six-inch mottled bed similar to J.

M has six feet of similar material to A, except that it is lighter, being more of a chocolate colour; and in N for four inches J is repeated. O again repeats M.

P is an eight-inch stratum, similar to J in being mottled, though of a lighter colour, changing to a yellowish-brown on exposure, but having on its under side lenticular masses of siliceous and calcareous breccia of a dark purplish colour, on which No. 6 trench and excavation were made.

Q has four feet more of the chocolate-coloured rubbly shales similar to M; and in R we have the bed in which the greatest amount of excavation was done, as on it were situated Nos. 2, 3, and 7. It is a six-inch, highly-laminated, chocolate-coloured shale, slightly calcareous, scaling off in thin flakes, and containing oval-shaped lenticular masses of dense, dark purplish calcareous sandstone, changing to a lighter colour on exposure.

The S bed immediately above this again resembles M for four feet, and then a nine-inch bed (T) of dense dark stone, changing to light chocolate or claret-coloured ferruginous and micaceous sandstone is seen.

Resting on this is a twelve feet bed (U), similar to M.

V is a two-feet stratum of irregularly-bedded ferruginous sandstone shale.

Above this is another two-feet bed (W), and highest of the series on this side of the river, though occurring only on the

* The numbers of the excavations are in the order of their commencement. For facilitating recognition by the workmen, and the correct reference of the fossils to their proper beds, the numbers of the excavations were fixed to each specimen.

lower part of the hill, no great distance above the river, apparently composed of similar material to the last, but more dense and compact; so much so that in quarrying, in one or two cases, blocks were dislodged some tons in weight, and very difficult to break up.

Some idea of the extent of the operations may be gained from the fact that the ten hands engaged, beside searching the surface over a large area, removed, in the five weeks during which the operations were continued, over five hundred tons of earth and rock, much of the latter having to be carefully broken and searched, to obtain the three hundred specimens with which our labour was rewarded.

Having determined these various strata, I now needed to obtain palæontological evidence of their age. There are considerable quantities of freestone on the surface, from which, occasionally, very interesting fossil specimens were, with considerable search, obtained.

On the evening of December 23rd, during a walk among some large heaps of stone collected from a patch of cultivated land below and to the north of "7," I had, looking between the stones as the setting sun cast its light in the interstices, espied distinct fish scale markings on an under stone, and on removing the stones pressing on it, found it to be the cast of a fish differing in appearance from any I had before seen. It was about thirteen inches long and four inches broad, with the scales and scale-markings deeply and plainly pitted in the stone. Neither the head nor tail are perfect, but the anal fin is both large and distinct, and the dorsal fin can also be discerned. This specimen has since been named *Cosmolepides sweeti* (McCoy).

Yet the importance of tracing these remains to their natural bed, and of obtaining them *in situ*, was fully recognised. To effect this, efforts were continued for some days, with the result that one bed (P) was suspected to be the one from which certain remains had come.

On the horizon of K, I had discovered portions of fish with a form of scale much smaller, but in other respects like that I had found on the 23rd, and retaining in this case their bony structure. I had set a man to work to trench up the hill side, hoping to strike the bed from whence they had come. While he was thus engaged on the morning of the 26th of December last, continuing myself the surface search near to him, I opened a stone by splitting it along the beding plane, and to my delight, a half of one of the

Ganoid fishes, some ten inches long and three inches broad, with its heterocercal tail, and portion of the trunk clearly defined, was exposed, also a portion of the anal fin; and on the stone being fully opened, it displayed in its scale-markings the same rhomboidal character observed in the large fish, with the osseous structure noticed in the smaller one discovered a few days before.

These were as finely sculptured, the form in some being very distinct. The scaly trunk is well shown, some of the scales in counterpart, with most of the head portions of the pectoral, anal, and caudal fins and gill plates. Nothing was observed of the internal skeleton of the trunk, and no traces of ossified ribs were seen. The fins, where not removed, have distinct rays. The specimen is in the hands of Professor McCoy, for complete description, by whom it has been named *Cosmolepides sweeti* (McCoy). The search was continued till the highly-laminated shale (R), with its oval-shaped lenticular masses on the under-side of varying thickness and size, from a few inches to three or four feet were met with. This bed was followed for some distance, when lenticular stones were opened, having the same lithological character as that in which the first whole fish was found, and in such masses we subsequently found most of the fish remains of that bed. When it had been proved that this was the bed from which the lenticular masses containing the fish had come, the discovery of the other fossil-bearing beds soon followed, so that now I am in a position to point out the several beds in which the particular fossils were found.

Several other trenches were opened up in the course of the search, for similar purposes.

We now come to observe the fossils found *in situ* at the various beds.

In the thirteen beds of rubbly shale, with an aggregate thickness of one hundred and fifty-two feet, but few organic remains were seen, except on the line of contact between them and the adjoining beds.

The first bed in ascending order containing many fossils was F. From this bed were obtained several *Ichthyodorulites*, a portion of large *Gyracanthus*-like spine, and a large bone belonging to the head of a *Ganoid* fish, with other large undetermined Ichthyic remains, now in the hands of Professor McCoy. A few scales, some an inch and a half in diameter, allied to *Glyptolepis*, and a tooth, about an inch in length of a conical form, curved and hollow, with a few

more fossils. But, owing to one part of the matrix being very hard, and the other quite soft, great difficulty was experienced, when after long search specimens were obtained, in preventing their destruction in relieving them sufficiently of the matrix to be recognisable.

In H, there are, here and there, patches an inch in thickness of comminuted fish-scales and bones, covered by a yellowish, pale green film; and in this film, as also occasionally in the lower parts of the bed, several fish were found, resembling *Cosmolepides sweeti* (McCoy), similar to that found near to and in No. 2. But though so thin, yet so refractory was this film found to be, that even when the dim outline of a fish could be seen, it was often found impossible to clear the film away and get at the fish without destroying it.

However, by removing a few scores of tons of earth and rock, and after expenditure of much labour, several specimens were secured, containing different parts, and in the aggregate, every part of the fish. It was here that a large heterocercal tail was found, measuring about six inches across, apparently *Cosmolepides sweeti* (McCoy). It was also near this horizon that the first larger fish of the same species was met with on December 23rd.

Large scales were rare in this bed, but one or two conical teeth were found here, and several spines, like those of *Gyracanthus obliquus* (McCoy).

P was found to be important, from its containing isolated patches of fossils of a species of very large fish, with large scales so nearly resembling, in some respects, the rare *Phyllolepis*, as to give one or two geologists an impression in favour of its identity with that little known species, or *Glyptolepis*.

These clusters provided considerable material for investigation, including large bony plates, one, eight inches by four, still retaining much of its original appearance and structure; large opercular plates, one probably the quadrate bone, exhibiting their radiating appearance and slightly corrugated edges; also one very large mass of bones of the skull of an undetermined fish; several detached, curved, and conical teeth about an inch long; large bones of the head of Rhizodont fish, and large portions of another jaw, with the teeth in position, and showing their internal structure. (These are now in Professor McCoy's hands).

Two specimens of jaws have since been found in softer stone, which I have succeeded in relieving from their matrix,

so that the whole of this portion of jaw can be inspected—one, showing twenty teeth of a conical shape, from one-quarter to three-eighths of an inch in height; the other, with a large double-pointed tooth with the apices missing, still about one inch by half an inch thick at the base, and one inch and three-quarters high, having portions of other much smaller teeth adjoining it. Also some constricted bones of various size from one inch to two inches in length —"probably hyoid bones of large fish"—and some long, fine, cylindrical bony spines, like detached branchiostegal rays have been found.

R.—This is the bed before referred to, as being the first in which I found the approximately complete fossil fish, *Cosmolepides sweeti*. From this bed, also, a sufficient number of specimens were obtained, to enable the whole of the parts to be fully made out. Conspicuous in this bed are the bi-lobed pittings everywhere observed, and covering every leaf of shale. It is here, also, that we find the first plant impressions *in situ*, lying in the same plane of bedding as the fish, and one or two specimens exhibiting unmistakable *Lepidodendron* characters. They are, however, of comparatively small size.

This bed has also yielded several specimens of a pitted structure like *Bothriolepis*, but in reality *Bothriobolus* (McCoy), but of different nature (Professor McCoy thinks it possibly ova, but its structure has not yet been made out). These are seen of large size, one being seven inches wide, nine inches long, and one and a half inches thick, but incomplete in length; and a shield-like form, about ten inches long by five inches broad (nearly perfect). Also several conical teeth like those before mentioned, from half an inch to an inch in length, with large plates retaining their bony structure, probably *Cephalaspidan*. Some others resembling, at a cursory glance, oblong shells; and the large scales, probably of *Glyptolepis*, were here obtained; also a portion of fish allied to *Scaphaspis*, and specimens of an Acanthoid fish. Another Acanthoid fish was obtained from here, about ten inches in length in its incomplete state, but it has apparently been about fourteen inches when the whole of the tail was intact. This shows most of the fins, retaining their bony spines *in situ*, and it is considered by Professor McCoy a very interesting specimen. He has in honour of Mr. Langtree, the energetic Secretary for Mines, named it *Chiraiapolus langtrei*. Some large gill-like plates, with radiating fibrous tissue, were

obtained here; also a fragment of jaw, showing internal structure of one large and one small tooth. A specimen, ten inches by six, showing parallel (apparently oblique) lines of very small shagreen-like scales; also many "cylindrical bones, probably of *Colocanth* fish showing canals." It was near this zone that I found a stone, containing casts of "nail-headed neural and hemal spines of *Colocanth* fish," in position, as when attached to the cartilaginous vertebra, which has left no imprint whatever; also a "portion of the trunk of a fish, allied to *Glyptolepis*," showing the large scales in position, and a small fish, "probably the body of a *Cephalaspidan*." These, with many *Gyracanthus*-like spines, and several other fossils, were all obtained from this bed.

T contained in parts numerous plants, which here attain a large size, one specimen left with Professor McCoy, being nine inches across, and one seen as a freestone was over twelve inches across. These specimens are found, in some cases, of considerable length, Professor McCoy having one of about four inches across, and over two feet in length; and longer fractured specimens were left behind.

V.—This bed gave us portions of a jaw, showing the dentition, and several *Gyracanthus* spines, with some undetermined structures; and scales of fish an inch and a quarter in diameter, and teeth. Portions of *Acanthoid* fish were obtained by Mr. Cresswell at this bed, near 10, in which sufficient of the structure can be made out to clearly discern the lateral line of enlarged scales; Professor McCoy has named this *Eupleurosmus cresswelli*. I also found portions of similar remains in this bed near 8. I found here also portions of a fish, having the same character as *Cosmolepides sweeti* (McCoy); a portion of fish allied to *Scaphaspis*, and a stone, eight inches by five inches, with tubercular elevations undetermined.

The W bed is the highest of the series on this side the river, and contains fossils in some respects similar to those described in the bed on which it rests, and apparently differing from it, only in that it seemed to contain less of the remains of the small and fragile fish, and more of the stronger bones, spines, &c., of the larger fish; and these seem to have attained a greater size at the period in which this bed was laid down, than when that below it was deposited. This yielded (at 9) a very large spine, resembling *Gyracanthus obliquus* (McCoy), about nine inches in length, with both the base and point perfect.

I have described the rocks of the one hill to the east of Bridge Creek, but an examination of the strata and fossils of the hill to the West of Bridge Creek shows unmistakably its relation to this one. Certainly, all the beds are not observable, as the river flats (recent) overlap the lower members of the group, but between those that are observable, there is perfect agreement.

It would be highly interesting and important to ascertain if the high hills to the north also contain these same beds, as, if they do, being so much higher than these, they should, on their northern or north-eastern flanks, present even better prospects of great results than did either of the hills which have been here described.

While in the locality, I succeeded in tracing the *Lepidodendra* along the eastern side of the Blue Range Creek to the top of the Hat Hill (over two thousand feet high), and brought back specimens which have been forwarded to Professor McCoy, who has identified some as the *Lepidodendron mansfieldense*. Time forbade me staying longer then, but I hope to be able (should no one more capable undertake the work) at no very distant date to return, and taking up the work where I left off, go on into the country beyond, and ascertain if any interesting geological features still remain to be observed and described, and if so, what.

Although at the risk of appearing egotistical, I think I can best summarise the general results of my work in the words of Professor M'Coy, who has provided me with the following, as well as other information, and wishes me to make this use of it:—

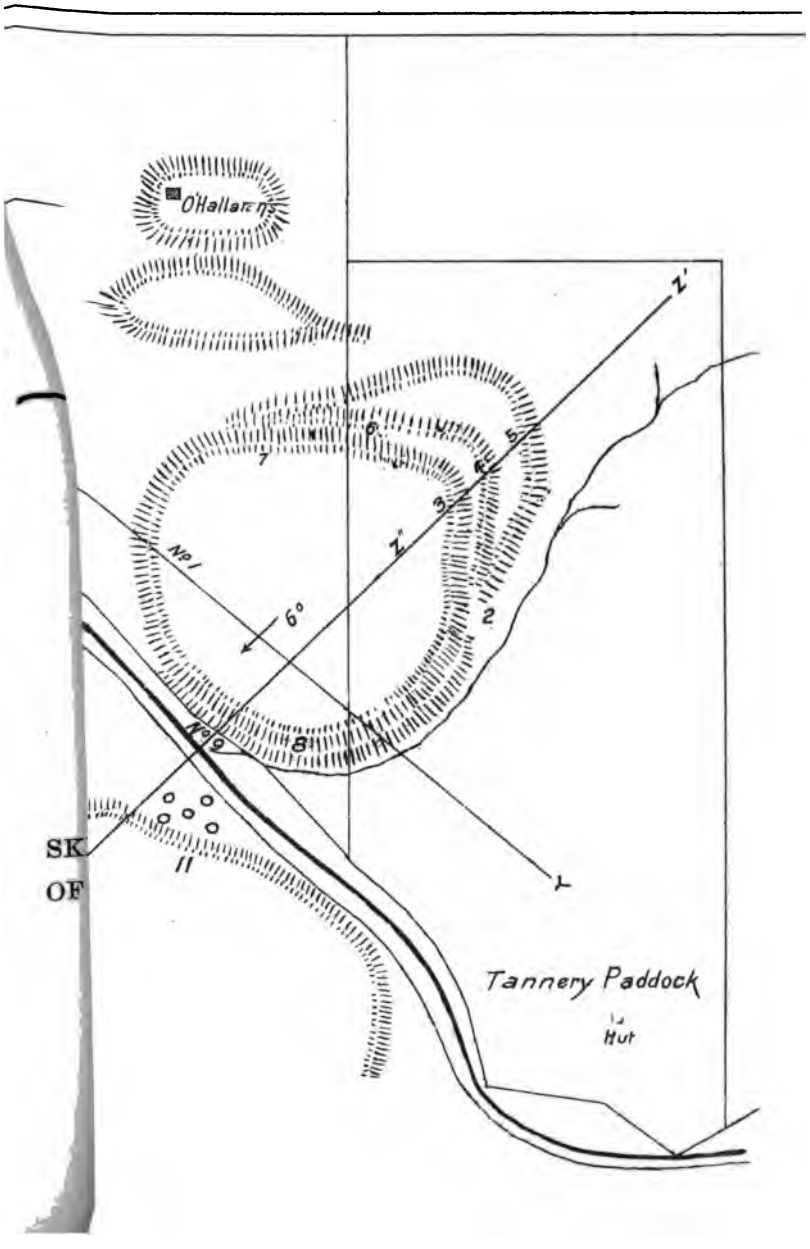
"The magnificent collections both of *Lepidodendron* and fish which you have made, and the pains and trouble which you have bestowed on the working out of many of these, and observing and plotting accurately on paper all the fossiliferous strata of the locality, deserve the warmest praise and thanks both from myself and the Department. You have satisfactorily determined the general fact, as I expected, of the superior position of the *Lepidodendra* to the majority of the fish beds; but, further, with a highly intelligent appreciation of the great geological interest of the point, you have proved—what was before uncertain—that they belonged to the same formation, by preserving and bringing down a slab of rock in which the remains of the vegetables and fishes were embedded together. In addition to a large series of all the organic remains found by your predecessors,

you have obtained evidence of several entirely new fishes of great interest, one of the most striking of which I have great pleasure in dedicating to you, as a memorial of your successful labours in clearing up this difficult piece of local geology and palæontology. You have also thrown a flood of light on the other species, by your skilful putting together of the fragments, and showing the relations of many parts by your painstaking clearing of these brittle remains from the hard matrix.

"The whole of these organic remains are now being carefully figured for the next decade of the Palæontology of Victoria, in which further acknowledgment will be made of the value of your friendly help."

In conclusion, my thanks are due, especially to Professor McCoy, in whose hands the specimens have been placed for description, and to whom I am indebted for the names and descriptions of various forms. To Mr. Murray, for the ready and thorough manner in which he employed his knowledge to assist me in finding the exact locality, &c., whence the first fossils found were obtained. To the Rev A. W. Cresswell, M.A., for information as to locality and notes of fossils found by him. To Mr. D. Mitchell, for permission to quarry on his estate; and to his managers, Mr. P. F. Nembegin and Mr. Loveband, for their kind assistance. To Mr. P. O'Halloran, for permission to quarry, and assistance. To Mr. McCartney, for permission to camp on the Battery Estate. To Mr. A. H. S. Lucas, M.A., B. Sc., and to Professor Spencer, for encouragement and advice, without whose kindly help, this paper would not, I think, have been presented, they being of opinion that the record of my work would be of interest and value.

Proc R.S. Victoria. Plate 1



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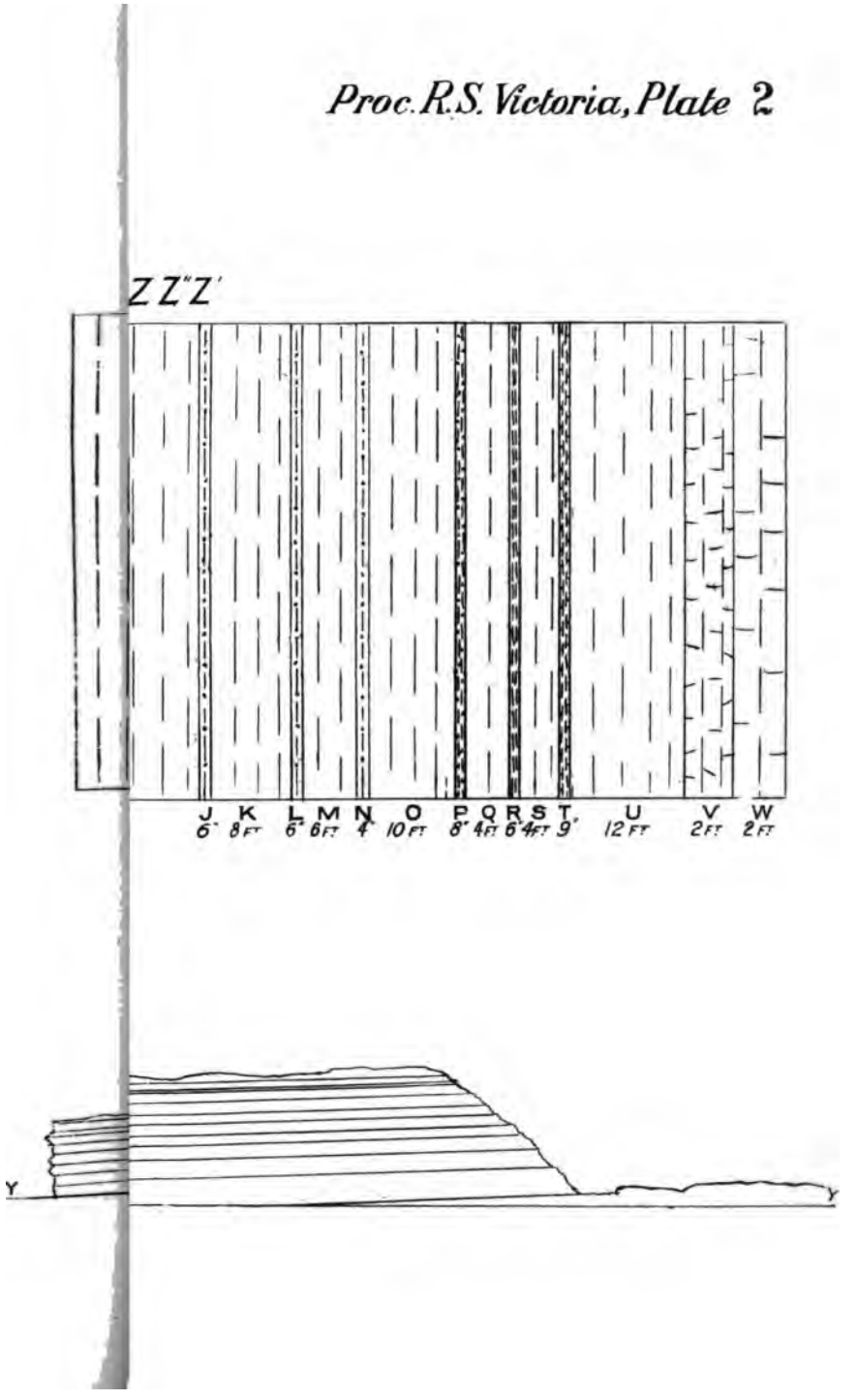

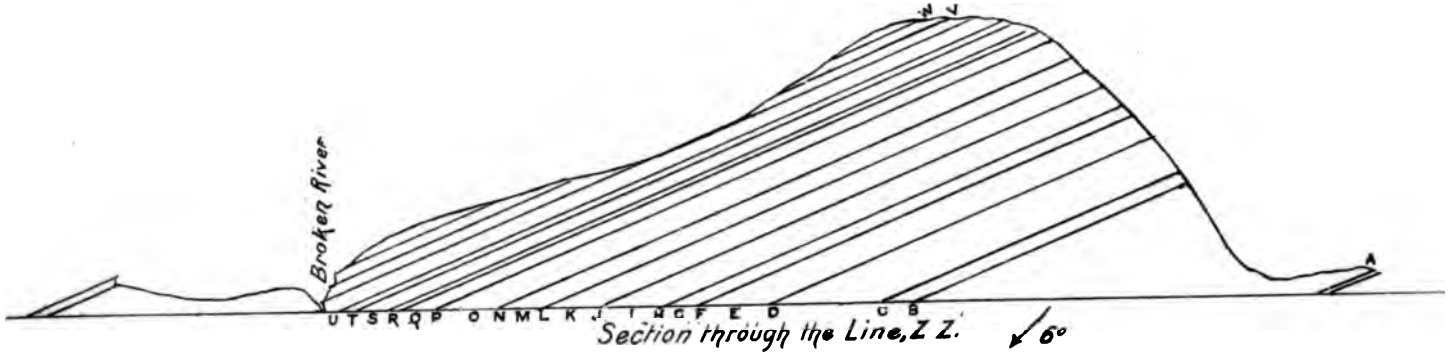
Broken River
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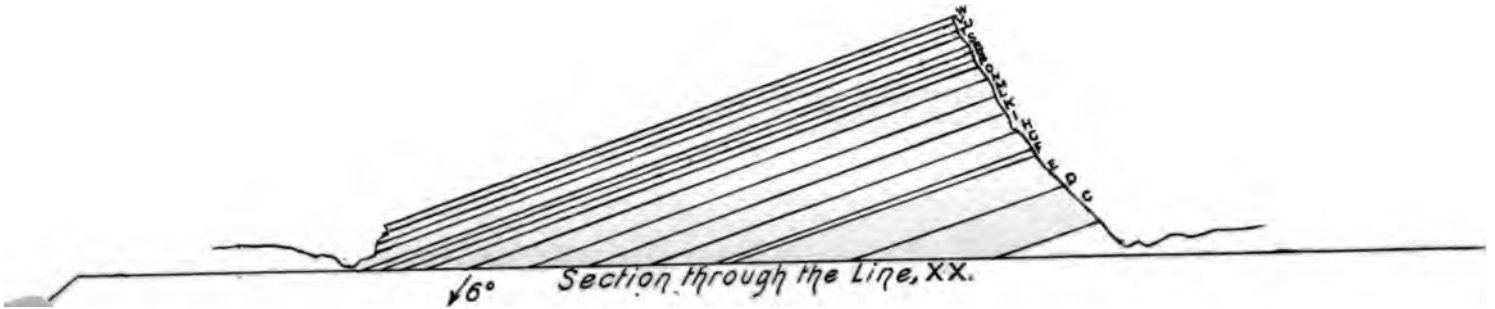
Section through the Line, XX.
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ART. II.—*A Systematic Census of Indigenous Fish, hitherto recorded from Victorian Waters.*

By A. H. S. LUCAS, M.A., B. Sc.

[Read April 6th, 1889.]

INTRODUCTION.

The classification followed in this Census is that adopted by the Hon. Sir William Macleay in his "Descriptive Catalogue of Australian Fish." It is, in the main, that of Dr. Günther, as elaborated in his "Catalogue of Fishes of the British Museum."

To each species is appended :—(1) The name of the author who, either originally described it, or who gave the *specific* name finally accepted, and an exact reference to the work in which the description or denomination first appeared, with the date of publication. (2) References to the more important synonyms, in cases where it was thought any ambiguity might exist. (3) A reference to the figure in case of those fish which have been figured. Where a fish has been figured more than once, usually only the latest or most accessible figure is recorded. The most important of these illustrations are the figures in the Plates of Professor M'Coy's "Prodromus of Victorian Zoology." (4) The localities from which the species have been obtained, as far as known with precision. (5) The vernacular name as used in Victoria. Those species of which only single specimens have been obtained appear in parentheses, as do any others of whose occurrence in Victorian waters there is any doubt. Amongst these last, I have included all the species described or labelled as coming from Hobson's Bay or Port Phillip by Dr. Klünzinger, in the "Archiv. f. Naturg. xxxvii," 1872, since it seems probable that some South Australian fish have been confused with others sent to the Stuttgart Museum from Victoria. It seemed wiser to incorporate in the Census the species as given by so considerable an authority as Dr. Klünzinger, but questions of local distribution can only be satisfactorily settled by resident local workers, and it remains for evidence to be forthcoming to vindicate Dr. Klünzinger's Victorian records.

As it stands, the list includes 233 species. There can be no doubt but that many additions will be made, especially of smaller species, and of species living in deeper waters, which require the use of the trawl for their capture. On the other hand, it seems highly probable that several forms ranked as species are really but varieties. This is notably the case in the genera Monacanthus, Labrichthys and possibly Galaxias.

Our Fish Fauna has been very tardily worked out, and much remains to be done even now. A few of our fish are world-wide in their distribution, and the species thus secured the great Linnæus as their sponsor. The first strictly Australian species described are, I believe, to be found in the pages of "White's Journal to New South Wales," published in 1790. Amongst these, a very few Victorian forms are figured, in company with the Great Brown Kingfisher, and other "*species non-descripti*," as White terms them. As expeditions from Europe became more frequent, Australian fish appear in the systematic works, first of Bloch and of Lacépède, and later on of Cuvier and Valenciennes. The voyages of the Freycinet Expedition, of the Astrolabe, Beagle, Erebus and Terror, added a large number of Australian species in the Zoological Appendices to their Narratives. To Drs. Quoy and Gaimard, to Jenyns, and to Sir John Richardson, we owe thus a number of descriptions. To the latter too, were forwarded several consignments of Tasmanian fish, and of course many of these are common to Victoria and Tasmania; but it was not until 1872 that a serious study was made of Victorian forms proper. In that year Count F. de Castelnau, well-known for his previous researches on the fish of South America and of the Cape of Good Hope, published in the "Proceedings of the Zoological Society of Victoria," descriptions of about 150 species, which he had obtained, mostly from the Melbourne Fish Market. In the succeeding year, he added notes on more species. The Count's labours have made the work of those who follow him mainly of a supplementary nature. Amongst others who have worked during the last twenty years at our fishes, have been Drs. Günther, Steindachner, Klünzinger, and especially the Hon. Sir William Macleay, of Sydney, who has done so much for Australian Ichthyology in many ways, and most of all by the publication of his excellent "Descriptive Catalogue of Australian Fish." Finally, Professor M'Coy has given detailed descriptions and figures, usually in colours, of over 50 species of our Victorian fish.

SUB-CLASS I.—TELEOSTEI.

ORDER I.—ACANTHOPTERYGII.

DIVISION I.—ACANTHOPTERYGII PERCIFORMES.

FAMILY PERCIDÆ.

LATES, Cuvier.

L. colonorum, Günther, A.M.N.H., p. 114, 1863.
Macleay Cat. 2.
Figured, M'Coy, Prodr. Zool. Vict., pl. 14.
Loc.—Gippsland Lakes. Occurs also at Sandridge and at the mouth of the Saltwater River, M'Coy, l.c.
Vernacular name—*Gippsland Perch.*

L. similis, Castelnau, P.Z.S. Vict. I, p. 44, 1872.
Macleay Cat. 3.
Loc.—Gippsland Lakes, scarce, Castelnau, l.c.

L. antarcticus, Castelnau, P.Z.S. Vict. I, p. 44, 1872.
Macleay Cat. 4.
Syn.—*L. colonorum, var.*, M'Coy, l.c.
Vernacular name—*Sea Perch.*

L. victoriæ, Castelnau, P.Z.S. Vict. I, p. 45, 1872.
Macleay Cat. 5.

MICROPERCA, Castelnau.

M. yarræ, Castelnau, P.Z.S. Vict. I, p. 48, 1872.
Macleay Cat. 12.
Loc.—Lower Yarra, Castelnau, l.c.

ENOPLOSUS, Lacépède.

E. armatus, White sp., Voyage to N.S.W., 1790.
Günther Cat. I, p. 81; Macleay Cat. 13.
Figured, White, Voy. to N.S.W., pl. 39.
Loc.—*Passim.*
Vernacular name—*Bastard Dorey, Old Wife, Zebra-fish.*

(ANTHIAS, Bloch.)

(*A. rasor*, Richardson, P.Z.S., p. 95, 1839.)
Günther Cat. I, p. 93; Macleay Cat. 16.
Figured, Richardson, T.Z.S., 1849, pl. 4.
Loc.—One specimen from Western Port, Castelnau, P.Z.S. Vict. I, p. 51.
Vernacular name—*Tasmanian Red Perch* or *Barber.*

(NANNOPERCA, Günther.)

(*N. obscura*, Klünzinger, Archiv. f. Naturg., xxxviii., 1872.)
Macleay Cat. Sup. 1144.
Loc.—"Yarra Lagoon," Klünzinger, l.c.

APOGON, Lacépède.

A. güntheri, Castelnau, P.Z.S. Vict. I, p. 46, 1872.
Macleay Cat. 91.
Syn.—Perhaps—*A. novæ hollandiæ*, Val. (Macleay, l.c.)

(*A. conspersus*, Klünzinger, Archiv. f. Naturg., xxxviii., 1872.)
Macleay Cat. Sup. 1141.
Loc.—Port Phillip, Klünzinger, l.c.

ARRIPIS, Jenyns.

A. truttaceus, Cuv. et Val., Poissons III, p. 50, 1829.
Günther Cat. I, p. 253; Macleay Cat. 112.
Syn.—Includes *A. salar*, Richardson, T.Z.S. III, p. 78.
Figured, M'Coy, Prodr. Zool. Vict., pl. 16, 17.
Loc.—*Passim.*
Vernacular name—*Salmon* and *Salmon-trout.*

A. georgianus, Cuv. et Val., Poissons VII, p. 451, 1831.
Macleay Cat. 111.
Figured, Richardson, Voy. Erebus and Terror, pl. 54.
Loc.—Common according to Count Castelnau. I have not seen it.
Vernacular name—*Roughey.*

OLIGORUS, Günther.

O. macquariensis, Cuv. et Val., Poissons III, p. 58, 1829.
Günther Cat. I, p. 251; Macleay Cat. 114.
Figured, M'Coy, Prodr. Zool. Vict., pl. 85, 86.
Loc.—Murray and tributaries; now Yarra.
Vernacular name—*Murray Cod.*

O. mitchellii, Castelnau, P.Z.S. Vict. II, p. 150, 1873.
Macleay Cat. 115.
Loc.—Murray R., Castelnau, l.c.
Vernacular name—*Murray Perch.*

CTENOLATES, Günther.

C. ambiguus, Richardson, Voy. Erebus and Terror, p. 25, 1846.
Günther Cat. I, p. 270; Macleay Cat. 118.
Figured, M'Coy, Prodr. Zool. Vict., pl. 84.
Syn.—*Dules auratus*, Castelnau, P.Z.S. Vict. I, p. 55.
Loc.—Murray and tributaries.
Vernacular name—*Murray Golden Perch.*

FAMILY PRISTIPOMATIDÆ.

MURRAYIA, Castelnau.

M. güntheri, Castelnau, P.Z.S. Vict. I, p. 61, 1872.
Macleay Cat. 121.
Loc.—Murray R., Castelnau, l.c.

M. cyprinoides, Castelnau, P.Z.S. Vict. I, p. 62, 1872.
Macleay Cat. 122.
Loc.—Murray R., Castelnau, l.c.
Vernacular name—*Murray Carp.*

M. bramoides, Castelnau, P.Z.S. Vict. I, p. 63, 1872.
Macleay Cat. 123.
Loc.—Murray R., Castelnau, l.c.
Vernacular name—*Murray Bream.*

M. riverina, Krefft, P.Z.S., p. 943, 1867.
Macleay Cat. 124.
Loc.—Murray and tributaries, Macleay, l.c.

(RIVERINA, Castelnau.)

(*R. fluviatilis*, Castelnau, P.Z.S. Vict. I, p. 64, 1872.)
Macleay Cat. 137.
Loc.—One specimen, Murray R., Castelnau, l.c.

THERAPON, Cuvier.

T. richardsoni, Castelnau, P.Z.S. Vict. I, p. 60, 1872.
Macleay Cat. 138.
Loc.—Murray R., Castelnau, l.c.
Vernacular name—*Murray Silver Perch.*

T. niger, Castelnau, P.Z.S. Vict. I, p. 59, 1872.
Macleay Cat. 139.
Loc.—Murray R., rare, Castelnau, l.c.
Vernacular name—*Murray Black Perch.*

HISTIOPTERUS, Richardson.

H. recurvirostris, Richardson, Voy. Erebus and Terror, p. 34, 1846.
Macleay Cat. 156.
Vernacular name—*Boar-fish.*

H. labiosus, Günther, P.Z.S. p. 658, 1871.
Macleay Cat. 157.
Figured, P.Z.S. 1871, pl. 59.
Loc.—Western Port and Port Phillip, Castelnau, P.Z.S. Vict. I, p. 112.

GERRES, Cuvier.

G. melbournensis, Castelnau, P.Z.S. Vict. I, p. 158, 1872.
Macleay Cat. 173.
Loc.—Victorian seas, Castelnau, l.c.

FAMILY NANDIDÆ.

RUPPELIA, Castelnau.

R. prolongata, Castelnau, P.Z.S. Vict. II, p. 51, 1873.
Macleay Cat. 218.
Loc.—Victorian seas, Castelnau, l.c.
Vernacular name—*Devil-fish* (Castelnau).

FAMILY MULLIDÆ.

UPENEOIDES, Bleeker.

U. vlamingii, Cuv. et Val., Poissons III, p. 452, 1829.
Günther Cat. I, p. 400 ; Macleay Cat. 222.
Figured, Cuv. et Val., l.c. pl. 71.
Loc.—Victorian seas, Castelnau, P.Z.S. Vict. II, p. 39.
Vernacular name—*Red Mullet.*

UPENEICHTHYS, Bleeker.

U. porosus, Cuv. et Val., Poissons III, p. 455, 1829.
Günther Cat. I, p. 400 ; Macleay Cat. 227.
Loc.—Victorian seas ; not very common.
Vernacular name—*Red Gurnet, Red Mullet.*

FAMILY SPARIDÆ.

GIRELLA, Gray.

G. tricuspidata, Cuv. et Val., Poissons VI, p. 372, 1830.
Günther Cat. I, p. 428 ; Macleay Cat. 231.
Figured, Richardson, Voy. Erebus and Terror, pl. 25.
Vernacular name—*Rock* or *Black Perch.*

G. simplex, Richardson, Voy. Erebus and Terror, p. 25, 1846.
Günther Cat. I, p. 429 ; Macleay Cat. 232.
Figured, M'Coy, Prodr. Zool. Vict., pl. 73.
Loc.—Gippsland Lakes ; not very uncommon in Port Phillip.
Vernacular name—*Ludrick.*

(*G. blackii*, Castelnau, P.Z.S. Vict. II, p. 41, 1873.)
Macleay Cat. 234.
Loc.—"The specimen," Castelnau, l.c.

NEOTEPHRŒOPS, Castelnau.

N. zebra, Richardson, Voy. Erebus and Terror, p. 70, 1846.
Günther Cat. I, p. 432 ; Macleay Cat. 239.
Loc.—*Passim.*
Vernacular name—*Zebra-fish.*

PAGRUS, Cuvier.

P. unicolor, Cuv. et Val., Poissons VI, p. 162, 1830.
Günther Cat. I, p. 468 ; Macleay Cat. 255.
Loc.—Port Phillip, and off south coast.
Vernacular name—*Schnapper* or *Snapper.*

CHRYSOPHRYS, Cuvier.

C. australis, Günther Cat. I, p. 494, 1859.
Macleay Cat. 259.
Figured, M'Coy, Prodr. Zool. Vict., pl. 4; Günther Cat. pl. 28.
Loc.—*Passim.*
Vernacular name—*Bream.*

(HAPLODACTYLUS, Cuv. et Val.)

(*H. mœandratus*, Solander (Richardson), T.Z.S. III, p. 83, 1849.)
Macleay Cat. Sup. 1161.
Loc.—Hobson's Bay, Klünzinger, Archiv. f. Naturg. xxxviii.

FAMILY CIRRHITIDÆ.

CHIRONEMUS, Cuv. et Val.

C. marmoratus, Günther Cat. II, p. 76, 1860.
Macleay Cat. 263.
Loc.—Victorian seas, Castelnau, P.Z.S. Vict. I, p. 73.
Vernacular name.—*Kelp-fish.*

CHILODACTYLUS, Cuvier.

C. macropterus, Richardson, P.Z.S., p. 62, 1850.
Günther Cat. II, p. 78; Macleay Cat. 267.
Syn.—*C. aspersus*, Richardson. (Johnston, Report of Royal Commission on Fisheries of Tasmania, 1883.)
Loc.—Off South Coast, Castelnau, P.Z.S. Vict. I, p. 74.

C. nigricans, Richardson, P.Z.S., p. 63, 1850.
Günther Cat. II, p. 79; Macleay Cat. 269.
Loc.—*Passim.*
Vernacular name—*Butter-fish.*

C. carponemus, Cuv. et Val., V, p. 362, 1830.
Günther Cat. II, p. 78; Macleay Cat. 266.
Figured, M'Coy, Prodr. Zool. Vict., pl. 173, 174.
Loc.—Port Phillip Heads, rare.

C. gibbosus, Richardson, T.Z.S. III, p. 102, 1849.
Günther Cat. II, p. 84; Macleay Cat. 271.
Figured, P.Z.S., 1859, pl. 2.
Loc.—Victorian, Castelnau, P.Z.S. Vict. I, p. 75.
Vernacular name—*Magpie Perch.*

C. spectabilis, Hutton, Fishes of N.Z., p. 8, 1872.
Macleay Cat. 272.
Loc.—Port Phillip, Macleay, l.c.

(*C. nebulosus*, Klünzinger, Archiv. f. Naturg., xxxviii, 1872.)
Macleay Cat. Sup. 1164.
Loc.—Queenscliff, Port Phillip, Klünzinger, l.c.

LATRIS, Richardson.

L. hecateia, Richardson, P.Z.S., p. 99, 1839.
Günther Cat. II, p. 86; Macleay Cat. 276.
Figured, T.Z.S. III, pl. 6.
Loc.—Bass' Straits, occasionally in Hobson's Bay, Castelnau, P.Z.S. Vict. I, p. 77.
Vernacular name—*Hobart Town Trumpeter.*

L. forsteri, Castelnau, P.Z.S. Vict. I, p. 77, 1872.
Macleay Cat. 278.
Loc.—"Said to be common on Gippsland Coast," Castelnau, l.c.
Vernacular name—*Bastard Trumpeter.*

(*L. bilineata*, Castelnau, P.Z.S. Vict. I, p. 79, 1872.)
Macleay Cat. 279.
Loc.—One specimen from Western Port, Castelnau, l.c.

(*L. inornata*, Castelnau, P.Z.S. Vict. I, p. 79, 1872.)
Macleay Cat. 280.
Loc.—One specimen from Western Port, Castelnau, l.c.

(LACEPEDIA, Castelnau.)

(*L. cataphracta*, Castelnau, P.Z.S. Vict. II, p. 43, 1873.)
Macleay Cat. 281.
Loc.—One specimen stuffed, Castelnau, l.c.

FAMILY SCORPÆNIDÆ.

SEBASTES, Cuv. et Val.

S. percoides, Richardson, Voy. Erebus and Terror, p. 23, 1846.
Günther Cat. II, p. 101; Macleay Cat. 282.
Figured, Voy. Erebus and Terror, pl. 15; M'Coy, Prodr. Zool. Vict., pl. 33.
Loc.—Port Phillip, Macleay, l.c.
Vernacular name—*Gurnet.*

S. allporti, Castelnau, P.Z.S. Vict. II, p. 40, 1873.
Macleay Cat. 283.
Loc.—Victorian seas, Castelnau, l.c.

SCORPÆNA, Artedi.

S. cruenta, Solander, A.M.N.H. IX, p. 217, 1842.
Günther Cat. II, p. 112; Macleay Cat. 284.
Syn.—*S. militaris*, Richardson, Voy. Erebus and Terror, p. 22.
Loc.—Port Phillip, Macleay, l.c.
Vernacular name—*Red Rock Cod.*

ENTROPOGON, Günther.

C. scorpænoides, Guichenot, Mém. Soc. Imp. des Sci. Nat., Cherbourg.
Macleay Cat. 298.
Syn.—*C. australis*, Castelnau, P.Z.S. Vict. I, p. 81.
Vernacular name—*Gurnet.*

ENTAROGE, Günther.

P. marmorata, Cuv. et Val., Poissons IV, p. 416, 1829.
Günther Cat. II, p. 132; Macleay Cat. 300.

FAMILY TEUTHIDÆ.

EUTHIS, Linnæus.

T. javus, L, Syst. Nat. I, p. 507.
Günther Cat. III, p. 315; Macleay Cat. 306.
Loc.—Hobson's Bay, Macleay, l.c.

DIVISION II.—ACANTHOPTERYGII BERYCIFORMES.

None recorded.

DIVISION III.—ACANTHOPTERYGII KURTIFORMES.

None recorded.

DIVISION IV.—ACANTHOPTERYGII POLYNEMIFORMES.

None recorded.

DIVISION V.—ACANTHOPTERYGII SCIÆNIFORMES.

FAMILY SCIÆNIDÆ.

CIÆNA, Cuv.

S. antarctica, Castelnau, P.Z.S. Vict. I, p. 100, 1872.
Macleay Cat. 329.
Syn. — Probably, *Corvina antarctica*, Steindachner, Sitzungsb. ak. Wiss. Wien, 1866.
Loc.—Occasional visitor in Bass's Straits, Castelnau, l.c.
Vernacular name—*King-fish.*

DIVISION VI.—ACANTHOPTERYGII XIPHIIFORMES.

None recorded.

DIVISION VII.—ACANTHOPTERYGII TRICHIURIFORMES.

FAMILY TRICHIURIDÆ.

HYRSITES, Cuv. et Val.

T. atun, Cuv. et Val., Poissons VIII, p. 196, 1831.
Günther Cat. II, p. 350; Macleay Cat. 336.
Syn.—*Scomber atun*, Vetensk. Acad. xii.; *T. altivelis*, Richardson, P.Z.S., 1839.

Figured, Cuv. et Val., Poissons, pl. 219; M'Coy, Prodr. Zool. Vict., pl. 44.
Loc.—Off south coast; Bass's Straits.
Vernacular name—*Barracouta* or *Barracoota.*

DIVISION VIII.—ACANTHOPTERYGII COTTOSCOMBRIFORMES.

FAMILY CARANGIDÆ.

TRACHURUS, Cuv. et Val.

T. trachurus, Cuv. et Val., Poissons IX, p. 11, 1833.
Günther Cat. II, p. 419; Macleay Cat. 347.
Syn.—*Caranx declivis*, Jenyns, Zool. Beagle Fish, p. 68, pl. 14; *Scomber trachurus*, Lin. Syst. Nat. i., p. 494.
Figured, Cuv. et Val., pl. 246; M'Coy, Prodr. Zool. Vict., pl. 18.
Loc.—Port Phillip, M'Coy.
Vernacular name—*Horse Mackerel.*

CARANX, Cuv. et Val.

C. georgianus, Cuv. et Val., Poissons IX, p. 85, 1833.
Günther Cat. II, p. 440; Macleay Cat. 350.
Figured, Voy. Erebus and Terror, pl. 58.
Loc.—Port Phillip, and off south coast.
Vernacular name—*Silver Trevally.*

SERIOLA, Cuvier.

S. lalandi, Cuv. et Val., Poissons V, p. 208, 1830.
Günther Cat. 463; Macleay Cat. 365, 368.
Syn.—*S. grandis*, Castelnau, P.Z.S. Vict. I, p. 115.
Figured, M'Coy, Prodr. Zool. Vict., pl. 172.
Vernacular name—*Yellow Tail*, or *King-fish.*

NEPTONEMUS, Günther.

N. travale, Castelnau, P.Z.S. Vict. I, p. 118, 1872.
Macleay Cat. 372.
Vernacular name—*Trevally.*

TEMNODON, Cuv. et Val.

T. saltator, Bl. syst. Ichthyol (Schneider), p. 35, 1801.
Günther Cat. II, p. 479; Macleay Cat. 375.
Loc.—Queenscliff.
Vernacular name—*Skipjack.*

(PAREQUULA, Steindachner.) (?)

(*P. bicornis*, Steindachner, Sitzungsb. ak. Wien, 1867.)
Macleay Cat. Sup., p. 25.
Loc.—Hobson's Bay. Requires confirmation.

FAMILY CYTTIDÆ.

ZEUS, Cuvier.

Z. australis, Richardson, Voy. Erebus and Terror, p. 136, 1846.
Macleay Cat. 386.
Syn.—Günther considers = *Z. faber*, *L.*, Cat. II, p. 393.
Vernacular name—*Southern John Dorey.*

CYTTUS, Günther.

C. australis, Richardson sp., Voy. Erebus and Terror, p. 137, 1846.
Günther Cat. II, p. 396; Macleay Cat. 387.
Syn.—*Capros australis*, Richardson, l.c.
Loc.—Hobson's Bay, M'Coy, Rep. Intercol. Exh., 1866.
Vernacular name—*Bastard Dorey.*

FAMILY CORYPHÆNIDÆ.

BRAMA, Risso.

B. raii, Bloch, Syst. Ichth. (Schneider), p. 99, 1801.
Günther Cat. II, p. 408; Macleay Cat. 389.
Figured, M'Coy, Prodr. Zool. Vict., pl. 133.
Loc.—Portland, 1884, M'Coy, l.c.
Vernacular name—*Ray's Sea Bream.*

FAMILY SCOMBRIDÆ.

SCOMBER, Artedi.

S. australasicus, Cuv. et Val., Poissons VIII, p. 36, 1831.
Günther Cat. II, p. 359; Macleay Cat. 392.
Syn.—*S. pneumatophorus*, De la Roche (M'Coy).
Figured, M'Coy, Prodr. Zool. Vict., pl. 28.
Loc.—Rarely in Hobson's Bay, in considerable numbers when it does appear; M'Coy, l.c.
Vernacular name—*Southern Mackerel.*

(*S. antarcticus*, Castelnau, P.Z.S. Vict. I, p. 106, 1872.)
Macleay Cat. 393.
Loc.—One specimen seen in Melbourne market, Castelnau.

(*S. janesaba*, Bleeker, Japan, p. 406, 1858.)
Günther Cat. II, p. 359; Macleay Cat. Sup. 1186.
Loc.—Hobson's Bay, Klünzinger.

(*S. tapeino-cephalus*, Bleeker, Japan, p. 407, 1858.)
Günther Cat. II, p. 361; Macleay Cat. Sup. 1188.
Loc.—Hobson's Bay, Klünzinger.

THYNNUS, Cuv. et. Val.

T. m'coyi, Castelnau, P.Z.S. Vict. I, p. 104, 1872.
Macleay Cat. 396.
Syn.—*T. thynnus*, *L.* (M'Coy).
Figured, M'Coy, Prodr. Zool. Vict., pl. 44.
Loc.—Hobson's Bay, Portland, Bass Straits, Queenscliff, M'Coy, l.c.
Vernacular name—*Tunny.*

(PELAMYS, Cuv. et Val.)

(*P. schlegelii*, M'Coy, Prodr. Zool. Vict., 1888.)
Syn.—Perhaps, *P. orientalis*, Schlegel (M'Coy.)
Figured, M'Coy, Prodr. Zool. Vict., pl. 155.
Loc.—Only one specimen caught in Port Phillip Bay, 1877, M'Coy, l.c.

(CYBIUM, Cuv.)

(*C. commersonii*, Lacép. Hist. des Poissons II, p. 600, 1800.)
Günther Cat. II, p. 370 ; Macleay Cat. 400.
Figured, M'Coy, Prodr. Zool. Vict., pl. 154.
Loc.—Only one specimen caught near Queenscliff, 1887, M'Coy, l.c.
Vernacular name—*Commerson's Mackerel.*

FAMILY TRACHINIDÆ.

KATHETOSTOMA, Günther.

K. lœve, Bloch, Syst. Ichth. (Schneider), p. 47, 1801.
Günther Cat. II, p. 231 ; Macleay Cat. 406.
Figured, Bloch, l.c., pl. 8.
Vernacular name—*Stone Lifter.*

(PSEUDAPHRITIS, Castelnau.)

(*P. bassii*, Castelnau, P.Z.S. Vict. I, p. 92, 1872.)
Macleay Cat. 411.
Loc.—One specimen taken in Bass's Straits, Castelnau.

SILLAGO, Cuv.

S. punctata, Cuv. et Val., Poissons III, p. 413, 1829.
Günther Cat. II, p. 245 ; Macleay Cat. 413.
Figured, Voyage Astrolabe, pl. 1.
Loc.—*Passim.*
Vernacular name—*Melbourne Whiting.*

(*S. maculata*, Quoy et Gaim., Exp. Freycinet Zool., p. 261, 1834.)
Günther Cat. II, p. 245 ; Macleay Cat. 412.
Figured, Q. et G., l.c., pl. 53.
Loc.—Seen only once, Castelnau, P.Z.S. Vict. I, p. 94.

BOVICHTHYS, Cuv. et Val.)

(*B. variegatus*, Richardson, Voy. Erebus and Terror, p. 56, 1846.)
Günther Cat. II, p. 250; Macleay Cat. 419.
Figured, Voy. Erebus and Terror, pl. 34.
Loc.—One dried specimen from Hobson's Bay, Castelnau, P.Z.S. Vict. II, p. 45.

FAMILY PEDICULATI.

HIRONECTES, Cuvier.

C. bifurcatus, M'Coy, Prodr. Zool. Vict., Decade 13, 1886.
Figured, M'Coy, Prodr. Zool. Vict., pl. 123.
Loc.—Port Phillip, M'Coy, l.c.

FAMILY COTTINA.

LATYCEPHALUS, Bl.

(*P. speculator*, Klünzinger, Archiv. f. Naturg., 1872.)
Macleay Cat. Sup. 1197.
Loc.—Hobson's Bay, Klünzinger.

nau,

P. bassensis, Cuv. et Val., Poissons IV, p. 247, 1829.
Günther Cat. II, p. 179; Macleay Cat. 444.
Syn.—*P. tasmanius*, Richardson, Voy. Erebus Terror, p. 23.
Figured, Voy. Erebus and Terror, pl. 18.
Loc.—Port Phillip.
Vernacular name—*Flathead.*

P. fuscus, Cuv. et Val., Poissons IV, p. 241, 1829.
Macleay Cat. 445.
Figured, Voy. Astrolabe, pl. 10.
Loc.—Port Phillip.
Vernacular name—*Grass Flathead.*

P. lœvigatus, Cuv. et Val., Poissons IV, p. 243, 1829.
Günther Cat. II, p. 179; Macleay Cat. 446.
Loc.—Port Phillip, Western Port.
Vernacular name—*Rock Flathead.*

(*P. proximus*, Castelnau, P.Z.S. Vict. I, p. 85, 1872.)
Macleay Cat. 447.
Loc.—Only seen once in Melbourne market, Castelnau, l.c.

P. richardsoni, Castelnau, P.Z.S. Vict. I, p. 82, 1872.
Macleay Cat. 448.

P. grandis, Castelnau sp., P.Z.S. Vict. I, p. 87, 1872.
Macleay Cat. 457.
Syn.—*Neoplatycephalus grandis*, Castelnau, l.c.

LEPIDOTRIGLA, Günther.

(*L. phalœna*, Cuv. et Val., Poissons IV, p. 83, 1829.)
Günther Cat. II, p. 197; Macleay Cat. 459.
Loc.—Melbourne, Günther (quoted by Macleay, l.c.)

(*L. sphynx*, Cuv. et Val., Poissons IV, p. 83, 1829.)
Günther Cat. II, p. 197; Macleay Cat. 460.
Loc.—One specimen, Castelnau, P.Z.S. Vict. I, p. 89.

L. vanessa, Richardson, Trans. Z.S. III, 1849.
Günther Cat. II, p. 197; Macleay Cat. 461.
Figured, M'Coy, Prodr. Zool. Vict., pl. 5.
Loc.—Hobson's Bay.
Vernacular name—*Butterfly Gurnard.*

TRIGLA, Artedi.

T. kumu, Less. and Garn., Voy. de la Coquille, Poissons, pl. 19, 1826–30.
Günther Cat. II, p. 204; Macleay Cat. 463.
Figured, M'Coy, Prodr. Zool. Vict., pl. 6.
Loc.—Hobson's Bay, M'Coy, l.c.
Vernacular name—*Kumu Gurnard.*

T. polyommata, Richardson, T.Z.S. III, p. 96, 1839.
Günther Cat. II, p. 204; Macleay Cat. 464.
Figured, Richardson, T.Z.S. III, pl. 5.
Vernacular name—*Flying Gurnard.*

KATHI

I

DIVISION IX.—ACANTHOPTERYGII GOBIIFORMES.

FAMILY GOBIIDÆ.

GOBIUS, Artedi.

(*G. bifrenatus*, Kner., Voy. Novara, Fishes, p. 177, 1868.)
Macleay Cat. 476.
Syn.—*G. bassensis*, Castelnau, P.Z.S. Vict. I, p. 123.
Figured, Voy. Novara, pl. 7.
Loc.—Only seen once, Castelnau, l.c.

G. castelnaui, Macleay Cat. 477, 1881.
Loc.—Hobson's Bay, Castelnau, l.c., p. 124.

(*G. pictus*, Castelnau, P.Z.S. Vict. I, p. 124, 1872.)
Macleay Cat. 479.
Loc.—One specimen, Castelnau, l.c., p. 124.

G. pulchellus, Castelnau, P.Z.S. Vict. I, p. 125, 1872.
Macleay Cat. 480.
Loc.—Western Port, Castelnau, l.c.

(*G. caudatus*, Castelnau, P.Z.S. Vict. II, p. 47, 1873.)
Macleay Cat. 481.
Loc.—Apparently only one specimen. See Castelnau, l.c.

(*G. nebulo-punctatus*, Cuv. et Val., Poissons XII, p. 58, 1837.)
Günther Cat. III, p. 26; Macleay Cat. Sup. 1202.
Loc.—King George's Sound and Victoria, Klünzinger.

ELEOTRIS, Gronov.

E. nudiceps, Castelnau, P.Z.S. Vict. I, p. 126, 1872.
Macleay Cat. 520.
Loc.—Very common in Lower Yarra, Castelnau, l.c.
Vernacular name—*Big-head*, Castelnau.

(*E. cyprinoides*, Cuv. et Val., Poissons XII, p. 248, 1837.)
Günther Cat. III, p. 118; Macleay Cat. Sup. 1206.
Figured, Klünzinger, Sitzb. k. Ak. Wiss., Wien., 1879, pl. 5.
Loc.—Murray River, Klünzinger, l.c.

CALLIONYMUS, L.

(*C. calauropomus*, Richardson, Voy. Erebus and Terror, p. 10, 1846.)
Günther Cat. III, p. 147; Macleay Cat. 540.
Figured, Voy. Erebus and Terror, pl. 7.
Loc.—One specimen from Hobson's Bay, Castelnau, P.Z.S. Vict. II, p. 49.

C. papilio, Günther, A.M.N.H. XIV., p. 197, 1864.
Macleay Cat. 541.
Syn.—*C. ocellifer*, Castelnau, P.Z.S. Vict. II, p. 49.
Loc.—Hobson's Bay, Castelnau.

DIVISION X.—ACANTHOPTERYGII BLENNIIFORMES.

FAMILY BLENNIIDÆ.

(SALARIAS, Cuv. et Val.)

(*S. mulleri*, Klünzinger, Sitzb. d. k. Ak. Wiss., Wien., p. 388, 1879.)
Macleay Cat. Sup. 1215.
Loc.—Hobson's Bay, Klünzinger, l.c.

CLINUS, Cuv.

C. despicillatus, Richardson, Zool. Journ., p. 90, 1839.
Günther Cat. III, p. 271; Macleay Cat. 572.
Figured, T.Z.S. III, pl. 6.
Loc.—Recorded as Victorian by Castelnau, P.Z.S. Vict. I, p. 129.

(*C. marmoratus*, Klünzinger, Archiv. f. Naturg., 1872.)
Macleay Cat. Sup. 1217.
Loc.—Port Phillip, Klünzinger, l.c.

CRISTICEPS, Cuv. et Val.

C. howittii, Castelnau, P.Z.S. Vict. II, p. 48, 1873.
Macleay Cat. 582.
Loc.—Western Port, Castelnau, l.c.

C. robustus, Günther, A.M.N.H. XX, p. 62, 1867.
Macleay Cat. 583.
Loc.—Melbourne, Günther, l.c.

C. multifenestratus, Castelnau, P.Z.S. Vict. I, p. 131, 1872; II, p. 48, 1873.
Macleay Cat. 586.

(*C. amœnus*, Castelnau, P.Z.S. Vict. II, p. 48, 1873.)
Macleay Cat. 587.
Loc.—One specimen, Victorian, Castelnau, l.c.

(*C. forsteri*, Castelnau, P.Z.S. Vict. I, p. 132, 1872.)
Macleay Cat. 588.
Loc.—One specimen, Melbourne, Castelnau, l.c.

(*C. tristis*, Klünzinger, Archiv. f. Naturg., 1872.)
Macleay Cat. Sup. 1218.
Loc.—Murray R., Klünzinger, l.c.

DIVISION XI.—MUGILIFORMES.

FAMILY SPHYRÆNIDÆ.

SPHYRÆNA, Artedi.

S. novæ-hollandiæ, Günther Cat. II, p. 335, 1860.
Macleay Cat. 603.
Loc.—*Passim.*
Vernacular name—*Pike.*

LANIOPERCA, Günther.

L. mordax, Günther, A.M.N.H., X, p. 183, 1872.
Macleay Cat. 608.
Syn.—*Dinolestes mülleri*, Klünzinger; *Neosphyræna multiradiata*, Castelnau.
Figured, M'Coy, Prodr. Zool. Vict., pl. 115.
Loc.—Port Phillip.

FAMILY ATHERINIDÆ.

ATHERINICHTHYS, Bleeker.

A. modesta, Castelnau, P.Z.S. Vict. I, p. 136, 1872.
Macleay Cat. 620.
Loc.—Hobson's Bay and Lower Yarra, Castelnau.

A. picta, Castelnau, P.Z.S. Vict. I, p. 137, 1872.
Macleay Cat. 622.
Loc.—Capt. Synnot's Dock, Lower Yarra, Castelnau.

A. cephalotes, Castelnau, P.Z.S. Vict. I, p. 137, 1872.
Macleay Cat. 623.
Loc.—Hobson's Bay, Castelnau.

(ATHERINOSOMA, Castelnau.)

(*A. vorax*, Castelnau, P.Z.S. Vict. I, p. 138, 1872.)
Macleay Cat. 627.
Loc.—One specimen from Cape Schanck, Castelnau, l.c.

FAMILY MUGILIDÆ.

MUGIL, Artedi.

(*M. peronii*, Cuv. et Val., Poissons II, p. 138, 1836.)
Macleay Cat. 635.
Loc.—One specimen from Western Port, Castelnau, P.Z.S. Vict. II, p. 151.

M. grandis, Castelnau, P.L.S. N.S.W. III, p. 386, 1879.
Macleay Cat. 629.
Loc.—*Passim.*
Vernacular name—*Sand Mullet.*

(*M. gelatinosus*, Klünzinger, Archiv. f. Naturg., 1872.)
Macleay Cat. Sup. 1225.
Loc.—Hobson's Bay, Klünzinger, l.c.

AGONOSTOMA, Günther.

A. diemensis, Richardson, Zool. Trans. III, p. 123, 1849.
Günther Cat. III, p. 465 ; Macleay Cat. 641.
Syn.—*A. forsteri*, Bleeker.
Loc.—*Passim.*
Vernacular name—*Mullet.*

A. lacustris, Castelnau, P.Z.S. Vict. I, p. 142, 1872.
Macleay Cat. 642.
Loc.—Gippsland Lakes.

MYXUS, Günther.

M. elongatus, Günther, P.L.S., N.S.W. IV, p. 426, 1879.
Günther Cat. III, p. 466 ; Macleay Cat. 643.
Loc.—Hobson's Bay, Günther, l.c.

DIVISION XII.—ACANTHOPTERYGII GASTEROSTEIFORMES.

None recorded.

DIVISION XIII.—ACANTHOPTERYGII CENTRISCIFORMES.

None recorded.

DIVISION XIV.—ACANTHOPTERYGII GOBIESOCIFORMES.

None recorded.

DIVISION XV.—ACANTHOPTERYGII CHANNIFORMES.

None recorded.

DIVISION XVI.—ACANTHOPTERYGII TÆNIIFORMES.

FAMILY TRACHYPTERIDÆ.

(REGALECUS, Brünn.)

(*R. banksii*, Cuv. et Val., Poissons X, p. 365, 1835.)
Günther Cat. III, p. 309.
Figured, M'Coy, Prodr. Zool., pl. 145.
Loc.—Bass' Straits, one specimen, M'Coy, l.c.
Vernacular name—*Oar Fish;* probably *Sea Serpent*, M'Coy.

TRACHYPTERUS, Gouan.

T. tœnia, Bl. Schn., p. 480, 1801.
Günther Cat. III, p. 302.
Figured, M'Coy, Prodr. Zool. Vict., pl. 122.
Loc.—Portland, M'Coy.

DIVISION XVII.—ACANTHOPTERYGII NOTACANTHIFORMES.

None recorded.

ORDER ACANTHOPTERYGII PHARYNGOGNATHI.

FAMILY POMACENTRIDÆ.

GLYPHISODON, Cuvier.

G. victoriæ, Günther, A.M.N.H. II, p. 116, 1862 (XI, 1873, p. 115).
Macleay Cat. 676.
Vernacular name—*Rock Perch.*

FAMILY LABRIDÆ.

LABRICHTHYS, Bleeker.

Vernacular name.—*Wrasses, or Parrot-fish.*

(*L. psittacula*, Richardson, P.Z.S., p. 26, 1840.)
Günther Cat. IV, p. 114; Macleay Cat. 696.
Figured, Voy. Erebus and Terror, pl. 56; Günther Cat. pl. 59.
Loc.—Only one specimen, Castelnau, P.Z.S. Vict. II, p. 52.

L. laticlavius, Richardson, Voy. Erebus and Terror, p. 128, 1846.
Günther Cat IV, p. 115; Macleay Cat. 698.
Figured, M'Coy, Prodr. Zool. Vict., pl. 163.
Loc.—Hobson's Bay, M'Coy, l.c.

L. bleekeri, Castelnau, P.Z.S. Vict. I, p. 148, 1872.
Macleay Cat. 705.
Figured, M'Coy, Prodr. Zool. Vict., pl. 134.
Loc.—Port Phillip.

L. richardsoni, Castelnau, P.Z.S. Vict. I, p. 150, 1872.
Macleay Cat. 706.
Loc.—Port Phillip.

L. ephippium, Günther, A.M.N.H. XI, p. 116, 1863.
Macleay Cat. 707.
Syn.—*L. vestita*, Castelnau, P.Z.S. Vict. I, p. 151, 1872.
Loc.—Port Phillip.

(*L. cuvieri*, Castelnau, P.Z.S. Vict. II, p. 53, 1873.)
Macleay Cat. 708.
Loc.—One specimen, Phillip Island, Castelnau, l.c.

(HETEROSCARUS, Castelnau.)

(*H. macleayi*, M'Coy, Prodr. Zool. Vict., Decade 17, 1888.)
Figured, M'Coy, Prodr. Zool. Vict., pl. 164.
Loc.—One specimen from Portland, M'Coy, l.c.

ODAX, Cuv. et Val.

O. richardsoni, Günther Cat IV, p. 241, 1862.
Günther Cat. IV, p. 241; Macleay Cat. 753.
Loc.—*Passim.*
Vernacular name—*Stranger.*

O. obscurus, Castelnau, P.Z.S. Vict. I, p. 154, 1872.
Macleay Cat. 756.

OLISTHEROPS, Richardson.

O. cyanomelas, Richardson, A.M.N.H., p. 291, 1851.
Günther Cat. IV, p. 243; Macleay Cat. 760.

ORDER ANACANTHINI.

FAMILY GADOPSIDÆ.

GADOPSIS, Richardson.

G. marmoratus, Richardson, Voy. Erebus and Terror, p. 122, 1846.
Gunther, Cat. 4, p. 318; Macleay Cat. 763.
Figured, Voy. Erebus and Terror, pl. 59.
Loc.—*Passim*, Victorian streams, especially south of Dividing Range.
Vernacular name—*Black-fish.*

FAMILY GADIDÆ.

LOTELLA, Kaup.

L. callarias, Günther, A.M.N.H., p. 116, 1863.
Macleay Cat. 766.
Figured M'Coy, Prodr. Zool. Vict., pl. 19.
Loc.—Port Phillip, M'Coy, l.c.
Vernacular name—Small-scaled *Rock Cod.*

PSEUDOPHYCIS, Günther.

P. barbatus, Günther, A.M.N.H., p. 116, 1863.
Macleay Cat. 769.
Figured, M'Coy, Prodr. Zool. Vict., pl. 20.
Loc.—*Passim.*
Vernacular name—*Rock Cod.*

(PHYSICULUS, Kaup.)

(*P. palmatus*, Klünzinger, Archiv. f. Naturg., xxxviii, 1872.)
Macleay Cat. Sup. 1244.
Loc.—Port Phillip, Klünzinger.

FAMILY OPHIDIIDÆ.

GENYPTERUS, Philippi.

G. australis, Castelnau, P.Z.S. Vict. I, p. 164, 1872.
Macleay Cat. 771.
Syn.—*G. tigerinus*, Klünzinger, Archiv. f. Naturg, 1872.
Figured, M'Coy, Prodr. Zool. Vict., pl. 27.
Loc.—*Passim.*
Vernacular name—*Rockling.*

FAMILY PLEURONECTIDÆ.

(PSEUDORHOMBUS, Bleeker.)

(*P. mulleri*, Klünzinger, Archiv. f. Naturg., xxxviii, 1872.)
Macleay Cat. Sup. 1247.
Loc.—Hobson's Bay, Klünzinger, l.c.

RHOMBOSOLEA, Günther.

R. flesoides, Günther, A.M.N.H. II., p. 117, 1863.
Macleay Cat. 788.
Loc.—Port Phillip, Günther.

R. bassensis, Castelnau, P.Z.S. Vict. I., p. 167, 1872.
Macleay Cat. 789.
Loc.—*Passim.*
Vernacular name—*Sole.*

R. victoriæ, Castelnau sp., P.Z.S. Vict. I., p. 168, 1872.
Macleay Cat. 790.
Loc.—*Passim.*
Vernacular name—*Flounder.*

NOTE.—Prof. M'Coy considers *R. victoriæ*, Castelnau = *R. flesoides*, Günther.

ORDER IV.—PHYSOSTOMI.

FAMILY SILURIDÆ.

)PIDOGLANIS, Günther.

C. tandanus, Mitchell Exp. I, p. 95, 2nd ed., 1839.
Günther Cat. V, p. 26; Macleay Cat. 806.
Figured, Mitchell Exp., pl. 6.
Loc.—Murray R. and tributaries.
Vernacular name—*Murray Cat-fish.*

FAMILY HAPLOCHITONIDÆ.

ıOTOTROCTES, Günther.

P. marœna, Günther Cat. V, p. 382, 1864.
Macleay Cat. 824.
Loc.—Southern rivers of Victoria, formerly in Yarra.
Vernacular name—*Yarra Herring.*

FAMILY SCOPELIDÆ.

ULOPUS, Cuv.

A. purpurissatus, Richardson, Icon. Pisc., p. 6, 1843.
Günther Cat. V, p. 403; Macleay Cat. 832.
Figured, M'Coy, Prodr. Zool. Vict., pl. 54, 55.
Loc.—Hobson's Bay, M'Coy, l.c.
Vernacular name—*Sergeant Baker* (at Sydney).

FAMILY GALAXIDÆ.

ALAXIAS, Cuv.

G. attenuatus, Jenyns, Zool. Beagle, Fishes, p. 121, 1842.
Günther Cat. VI, p. 210; Macleay Cat. 843.
Figured, Zool. Beagle, pl. 22.
Syn.—*G. scriba*, Richardson, Voy. Erebus and Terror, p. 75; *G. maculatus*, Richardson, Voy. Erebus and Terror, p. 76.
Loc.—Very common in Lower Yarra, Castelnau, P.Z.S. Vict. I, p. 177.
Vernacular name—*Yarra Gudgeon.*

G. ocellatus, M'Coy, Internat. Exch. Essays, p. 14, 1866-7.
Macleay Cat. 852.
Loc.—R. Yarra.
Vernacular name—*Yarra Trout.*

G. cylindricus, Castelnau, P.Z.S. Vict. I, p. 177, 1872.
Macleay Cat. 853.
Loc.—R. Yarra, Castelnau, l.c.

G. delicatulus, Castelnau, P.Z.S. Vict. I, p. 178, 1872.
Macleay Cat. 854.
Loc.—R. Yarra, Castelnau, l.c.

G. amœnus, Castelnau, P.Z.S. Vict. I, p. 178, 1872.
Macleay Cat. 855.
Loc.—R. Yarra, Castelnau, l.c.

(*G. versicolor*, Castelnau, P.Z.S. Vict. I, p. 176, 1872.)
Macleay Cat. 856.
Loc.—One specimen from marsh near St. Kilda, Castelnau, l.c.

G. ornatus, Castelnau, P.Z.S. Vict. II, p. 153, 1873.
Macleay Cat. 857.
Loc.—Cardinia Creek, Castelnau.

(*G. rostratus*, Klünzinger, Archiv. f Naturg., p. 41, 1872.)
Macleay Cat. Sup. 1265.
Loc.—Murray R., Klünzinger, l.c.

(*G. obtusus*, Klünzinger, Archiv. f. Naturg., p. 41, 1872.)
Loc.—Yarra Lagoon, Klünzinger, l.c.

FAMILY SCOMBRESOCIDÆ.

SCOMBRESOX, Lacép.

S. forsteri, Cuv. et Val. XVIII, p. 481, 1846.
Günther Cat. VI, p. 258; Macleay Cat. 866.
Syn.—*S. saurus* (Bloch sp.), var. *forsteri* (Cuv. et Val.), according to M'Coy.
Figured, M'Coy, Prodr. Zool. Vict., pl. 135.

HEMIRAMPHUS, Cuvier.

H. intermedius, Cant., A.M.N.H. IX, p. 485, 1842.
Günther Cat. VI, p. 260; Macleay Cat. 867.
Syn.—*H. melanochir*, Cuv. et Val.
Figured, M'Coy, Prodr. Zool. Vict., pl. 135.
Vernacular name—*Gar-fish.*

FAMILY CYPRINIDÆ.

NEOCARASSIUS, Castelnau.

N. ventricosus, Castelnau, P.Z.S. Vict. I, p. 237, 1872.
Macleay Cat. 881.
Loc.—Saltwater R., Castelnau, l.c.

FAMILY GONORHYNCIDÆ.

GONORHYNCUS, Gronov.

G. greyi, Richardson, Voy. Erebus and Terror, p. 44, 1846.
Günther Cat. VII., p. 373; Macleay Cat. 883.
Syn.—*G. brevis*, Kner. Voy. Novara, p. 342.
Figured, Voy. Novara, pl. 16.
Loc.—*Passim.*
Vernacular name—*Sand-eel.*

FAMILY CLUPEIDÆ.

ENGRAULIS, Cuv. et Val.

E. antarcticus, Castelnau, P.Z.S. Vict. I, p. 186, 1872.
Macleay Cat. 885.
Syn.—*E. encrasicholus, var. antipodum*, Günther.
Loc.—*Passim.*
Vernacular name—*White-bait.*

(*E. heterolobus*, Rüpp.)
Günther Cat. VII, p. 392; Macleay Cat. Sup. 1272.
Loc.—Hobson's Bay, Klünzinger, Archiv. f. Naturg. 1872.

CHATOESSUS, Cuv. et Val.

C. richardsoni, Castelnau, P.Z.S. Vict. II, p. 144, 1873.
Macleay Cat. 888.
Loc.—Murray R., Castelnau.

CLUPEA, Cuvier.

C. sagax, Jenyns, Zool. Beagle, p. 134, 1842.
Günther Cat. VII, p. 443; Macleay Cat. 890.
Syn.—*Alosa melanosticta*, Cuv. et Val., Poissons XX, p. 444
Loc.—*Passim.*
Vernacular name—*Pilchard.*

C. vittata, Castelnau, P.L.S. N.S.W., IV, p. 379, 1879.
Macleay Cat. 896.
Vernacular name—*Smelt*, Castelnau, P.Z.S. Vict. I, p. 190.

FAMILY MURÆNIDÆ.

ANGUILLA, Cuvier.

A. reinhardtii, Steind. Sitzb. Ak. Wiss., Wien, 1867.
Günther Cat. VIII., p. 27; Macleay Cat. 910.
Loc.—From Western Port, and also, I believe, from the Mordialloc R., Castelnau, P.Z.S. Vict. I., p. 193.
Vernacular name—Confused with the common *Eel*, Castelnau, l.c.

A. australis, Richardson, Voy. Erebus and Terror, p. 112, 1846.
Günther Cat. VIII., p. 36; Macleay Cat. 911.
Figured, Voy. Erebus and Terror, pl. 45.
Loc.—Fresh waters *passim.*
Vernacular name—*Common Eel.*

CONGER, Cuvier.

C. wilsoni, Castelnau, P.Z.S. Vict. I., p. 193, 1872.
Macleay Cat. 914.
Loc.—*Passim.*
Vernacular name—*Silver Eel.*

(CONGROMURÆNA, Kaup.)

(*C. habenata*, Richardson, Voy. Erebus and Terror, p. 109, 1846.)

Günther Cat. VIII., p. 42 ; Macleay Cat. 916.

Figured, Voy. Erebus and Terror, pl. 50.

Loc. — One specimen seen in Melbourne market, Castelnau, P.Z.S. Vict. I., p. 195.

(MURÆNICHTHYS, Bleeker.)

(*M. macropterus*, Bleeker, Atlas Ichthy., p. 31.)

Günther Cat. VIII, p. 52 ; Macleay Cat. Sup. 1278.

Figured, Bleeker Atlas, pl. 7.

Loc.—Port Phillip, Klünzinger, Archiv. f. Naturg. 1872.

FAMILY PEGASIDÆ.

PEGASUS, L.

P. lancifer, Kaup. Wiegm. Archiv., p. 117, 1868.

Günther Cat. VIII, p. 149 ; Macleay Cat. 946.

Loc.—Port Phillip, not uncommon.

ORDER V.—LOPHOBRANCHII.

FAMILY SYNGNATHIDÆ.

Group Syngnathina.

SYNGNATHUS, Artedi.

S. semifasciatus, Günther Cat. VIII., p. 162, 1870.

Günther Cat. VIII., p. 162 ; Macleay Cat. 947.

Syn.—*S. semistriatus*, Kaup (Macleay.)

Loc.—Port Phillip.

Vernacular name—*Pipe-fish.*

(*S. caretta*, Klünzinger, Sitzb. der K. Ak. Wiss., Wien, p. 419, 1879.)

Macleay Cat. Sup. 1281.

Loc.—Port Phillip, Klünzinger, Archiv. f. Naturg., 1872.

UROCAMPUS, Günther.

U. carinirostris, Castelnau, P.Z.S. Vict. I., p. 200, 1872.

Macleay Cat. 961.

Loc.—Port Phillip, Castelnau, l.c.

(LEPTOICHTHYS, Kaup.)

(*L. fistularius*, Kaup, Lophobr, p. 51.)

Günther Cat. VIII, p. 187 ; Macleay Cat. 962.

Loc.—Port Phillip, Klünzinger, Archiv. f. Naturg., 1872.

STIGMATOPHORA, Kaup.

S. argus, Richardson, T.Z.S. III., p. 183, 1849.
Günther Cat. VIII, p. 189 ; Macleay Cat. 965.
Figured, T.Z.S. III., pl. 7.
Loc.—Sandridge (specimens in Melbourne Museum).

S. nigra, Kaup, Lophobr, p. 53.
Günther Cat. VIII, p. 190 ; Macleay Cat. 966.
Loc.—Sandridge (specimens in Melbourne Museum).

Group Hippocampina.

(GASTROTOKEUS, Kaup.)

G. gracilis, Klünzinger, Archiv. f. Naturg., p. 44, 1872.
Loc.—Port Phillip, Klünzinger, l.c.

(SOLENOGNATHUS, Kaup.)

S. spinosissimus, Günther Cat. VIII, p. 195, 1870.
Günther Cat. VIII, p. 195 ; Macleay Cat. 973.
Loc.—Port Phillip, Klünzinger, l.c.

PHYLLOPTERYX, Kaup.

P. foliatus, Shaw, Gen. Zool. V, p. 456, 1803.
Günther Cat. VIII, p. 196 ; Macleay Cat. 974.
Figured, M'Coy, Prodr. Zool., pl. 65.
Loc.—*Passim.*
Vernacular name—*Sea-dragon.*

HIPPOCAMPUS, Leach.

H. abdominalis, Kaup, Lophobr., p. 17.
Günther Cat. VIII, p. 199 ; Macleay Cat. 978.
Loc.—Port Phillip, Klünzinger. J. Bracebridge Wilson dredged it outside the Heads, 1888.
Vernacular name—*Sea-horse.*

H. breviceps, Peters, Monatsber. Ak. Wiss., Berlin, p. 710, 1869.
Günther Cat. VIII, p. 200 ; Macleay Cat. 980.
Figured, M'Coy, Prodr. Zool. Vict., pl. 65.
Loc.—*Passim.*
Vernacular name—*Short-headed Sea-horse.*

H. novæ-hollandiæ, Steind., Sitzungsb. Ak. Wiss., Wien, p. 474, 1866.
Günther Cat. VIII, p. 201 ; Macleay Cat. 982.
Loc.—Port Phillip, Macleay.
Vernacular name—*Sea-horse.*

(*H. tristis*, Castelnau, P.Z.S. Vict. I, p. 197, 1872.)
Macleay Cat. 983.
Loc.—One specimen from Port Phillip, Castelnau, l.c.

ORDER VI.—PLECTOGNATHI.

FAMILY SCLERODERMI.

MONACANTHUS, Cuvier (Leather Jackets).

M. hippocrepis, Quoy and Gaimard, Voy. Uran. Zool., p. 212, 1824.
Günther Cat. VIII, p. 246; Macleay Cat. 992.
Syn.—*Aleuterius variabilis*, Richardson, Voy. Erebus and Terror, p. 67.
Figured, Voy. Erebus and Terror, pl. 53; M'Coy, Prodr. Zool. Vict., pl. 125.

(*M. convexirostris*, Günther Cat. VIII, p. 248, 1870.)
Günther Cat. VIII, p. 248; Macleay Cat. 994.
Loc.—Port Phillip, Hobson's Bay, Klünzinger, Archiv. f. Naturg., 1872.

M. güntheri, Macleay Cat. 998, 18 .
Syn.—*M. peronii*, Günther Cat. VIII, p. 249.
Figured, M'Coy, Prodr. Zool. Vict., pl. 143.
Loc.—Port Phillip Heads, Warrnambool, M'Coy, l.c.

M. browni, Richardson, sp., Voy. Erebus and Terror, 1846.
Figured, M'Coy, Prodr. Zool. Vict., pl. 124.
Loc.—Bass's Straits, M'Coy.

(*M. maculosus*, Richardson, Voy. Erebus and Terror, p. 67, 1846.)
Macleay Cat. 1001.
Figured, Voy. Erebus and Terror, pl. 39; Hollard, Ann. Sci. Nat. Zool. 1854, pl. 14.
Loc.—Port Phillip, Klünzinger, Archiv. f. Naturg., xxxviii.

(*M. forsteri*, Castelnau, P.Z.S. Vict. I, p. 204, 1872.)
Macleay Cat. 1005.
Loc.—One specimen, Castelnau, l.c.

(*M. prasinus*, Castelnau, P.Z.S. Vict. I, p. 205, 1872.)
Macleay Cat. 1006.
Loc.—Only seen once, Castelnau, l.c.

(*M. baudini*, Castelnau, P.Z.S. Vict. II, p. 55, 1873.)
Macleay Cat. 1007.
Loc.—One specimen from coast of Victoria, Castelnau, l.c.

(*M. lesueurii*, Castelnau, P.Z.S. Vict. II, p. 56, 1873.)
Macleay Cat. 1008.
Loc.—One specimen from Western Port, Castelnau, l.c.

M. sancti-joanni, Castelnau, P.L.S. N.S.W. II, p. 246, 1877.
Macleay Cat. 1012.
Loc.—Hobson's Bay, Castelnau, l.c.

(*M. granulatus*, White, Voy. N.S.W., p. 295, 1790.)
Günther Cat. VIII, p. 243; Macleay Cat. 1019.
Figured, Voy. Erebus and Terror, pl. 40.
Loc.—Port Phillip, Klünzinger, Archiv. f. Naturg., xxxviii.

M. rudis, Richardson, Voy. Erebus and Terror, p. 65, 1846.
Günther Cat. VIII, p. 244; Macleay Cat. 1020.
Loc.—Bass's Straits, Castelnau, P.Z.S. Vict. II, p. 54.

M. trossulus, Richardson, Voy. Erebus and Terror, p. 68, 1846.
Günther Cat. VIII, p. 234; Macleay Cat. 1025.
Loc.—Victoria, Macleay, l.c.

OSTRACION, Artedi.

O. auritus, Shaw, T.Z.S. III, p. 160, 1849.
Günther Cat. VIII, p. 266; Macleay Cat. 1036.
Figured, T.Z.S. III, pl. 9.
Loc.—Port Phillip, Phillip I.

O. amœnus, Castelnau, P.Z.S. Vict. I, p. 207, 1872.
Macleay Cat. 1039.
Loc.—Port Phillip.

FAMILY GYMNODONTES.

TETRODON, Bibr.

T. hamiltoni, Richardson, Voy. Erebus and Terror, p. 63, 1846.
Günther Cat. VIII, p. 280; Macleay Cat. 1045.
Figured, Voy. Erebus and Terror, pl. 39.
Loc.—Port Phillip.
Vernacular name—*Toad-fish.*

(*T. richei*, Fréminv, Nouv. Bull. Philom. II, p. 250.)
Günther Cat. VIII, p. 285; Macleay Cat. 1046.
Figured, Bleeker, Atlas, pl. 9.
Loc.—Port Phillip, Klünzinger, Archiv. f. Naturg. xxxviii.

T. hispidus, L. Syst. Nat. I, p. 411.
Günther Cat. VIII, p. 297; Macleay Cat. 1053.

DIODON, Linnæus.

D. spinosissimus, Cuv. Mém. Mus., p. 134, 1818.
Günther Cat. VIII, p. 307; Macleay Cat. 1060.
Loc.—Port Phillip, Castelnau, P.Z.S. Vict. I, p. 2.

D. blochii, Castelnau, P.Z.S. Vict. I, p. 210, 1872.
Macleay Cat. 1062.
Loc.—Port Phillip, Castelnau, l.c.
Vernacular name—*Porcupine-fish.*

(CHILOMYCTERUS, Bibr.)

(*C. jaculiferus*, Cuv. Mém. Mus., p. 130, 1818.)
Günther Cat. VIII, p. 313; Macleay Cat. 1063.
Loc.—One specimen from Hobson's Bay, Castelnau, P.Z.S. Vict. I, p. 211.

ORTHAGORISCUS, Bloch., Syst. Ichthy. Ol. (Schneider), p. 510, 1801.

O. mola, L.
Günther Cat. VIII, p. 317; Macleay Cat. 1063.
Vernacular name—*Sun-fish.*

SUB-CLASS II.—PALÆICHTHYES.

ORDER I.—GANOIDIÆ.

None recorded.

ORDER II.—CHONDROPTERYGII.

FAMILY CHIMÆRIDÆ.

CALLORHYNCUS, Gronovius.

C. antarcticus Lacépède Hist. Poissons I, p. 400, 1798.
Günther Cat. VIII, p. 351; Macleay Cat. 1070.
Syn.—*C. peronii*, Dum.
C. capensis, Dum.
C. australis, Shaw and Owen.
C. tasmanius, Richardson.
Loc.—Port Phillip Heads and S. Coast.
Vernacular name—*Elephant-shark.*

FAMILY CARCHARIIDÆ.

(CARCHARIAS, Cuvier.)

(*C. melanopterus*, Muller and Henle, p. 43, 1841.)
Günther Cat. VIII, p. 369; Macleay Cat. 1077.
Loc.—One specimen from Hobson's Bay, M'Coy.

GALEUS, Cuvier.

G. australis, Macleay Cat. 1079, 1880.
Figured, M'Coy, Prodr. Zool. Vict., pl. 64.
Loc.—*Passim.*
Vernacular name—*Tope.*

ZYGÆNA, Cuvier.

Z. malleus, Shaw, Nat. Misc.
Günther Cat. VIII, p. 381; Macleay Cat. 1080.
Figured, M'Coy, Prodr. Zool. Vict., pl. 56.
Loc.—Port Phillip.
Vernacular name—*Hammer-headed Shark.*

MUSTELUS, Cuvier.

M. antarcticus, Günther Cat. VIII, p. 387, 1870.
Macleay Cat 1081.
Figured, M'Coy, Prodr. Zool. Vict., pl. 87.
Loc.—*Passim.*
Vernacular name—*Smooth-hound, Gummy.*

FAMILY LAMNIDÆ.

CARCHARODON, Muller and Henle.

C. rondeletii, Muller and Henle, p. 70, 1841.
Günther Cat. VIII, p. 392; Macleay Cat. 1083.
Figured, M'Coy, Prodr. Zool. Vict., pl. 74.
Loc.—Hobson's Bay, M'Coy, l.c.
Vernacular name—*White Shark.*

ODONTASPIS, Agassiz.

O. americanus, Mitch. sp., Phil. and Lit. Trans. New York, I, p. 483.
Günther Cat. VIII, p. 392; Macleay Cat. 1084.
Syn.—*O. taurus*, Muller and Henle, p. 73.
Figured, M'Coy, Prodr. Zool. Vict., pl. 64.
Loc.—Hobson's Bay, M'Coy, l.c.

ALOPECIAS, Muller and Henle.

A. vulpes, L. Syst. Nat. Cuv. Gmelin I, p. 1496, 1788.
Günther Cat. VIII, p. 393; Macleay Cat. 1085.
Figured, M'Coy, Prodr. Zool. Vict., pl. 88.
Loc.—Hastings, M'Coy, l.c.; Queenscliff, J. Brace-bridge Wilson.
Vernacular name—*Thresher Shark.*

FAMILY NOTIDANIDÆ.

NOTIDANUS, Cuvier.

N. indicus, Cuvier, Regne Animal, 1830.
Günther Cat. VIII, p. 398; Macleay Cat. 1086.
Figured, M'Coy, Prodr. Zool. Vict., pl. 43.
Loc.—Hobson's Bay, M'Coy, l.c.

FAMILY SCYLLIDÆ.

PARASCYLLIUM, Gill.

P. nuchale, M'Coy, A.M.N.H. XIII, p. 15, 1874.
Macleay Cat. 1090.
Figured, M'Coy, l.c., pl. 2.
Loc.—Port Phillip, M'Coy, l.c.

CROSSORHINUS, Muller and Henle.

C. barbatus, L. Syst. Nat. Cuv. Gmelin, p. 1493, 1788.
Günther Cat. VIII, p. 414; Macleay Cat. 1095.
Figured, M'Coy, Prodr. Zool. Vict., pl. 43.
Loc.—Hobson's Bay, M'Coy, l.c.
Vernacular name—*Carpet Shark, Wobbigong.*

FAMILY CESTRACIONTIDÆ.

HETERODONTUS, De Blainville.

H. phillipii, Lacépède, Hist. des Poissons I, p. 218, 1798.
Macleay Cat. 1097.
Figured, M'Coy, Prodr. Zool. Vict., pl. 113.
Loc.—*Passim.*
Vernacular name—*Port Jackson Shark, Pig-fish.*

FAMILY SPINACIDÆ.

ACANTHIAS, Muller and Henle.

A. vulgaris, L. Syst. Nat., p. 397.
Günther Cat. VIII, p. 418; Macleay Cat. 1099.
Figured, M'Coy, Prodr. Zool. Vict., pl. 75.
Loc.—Hobson's Bay, M'Coy, l.c.
Vernacular name—*Picked Dog-fish.*

(ECHINORHINUS, De Blainville.)

(*E. spinosus*, L. Syst. Nat. Cuv. Gmelin I, p. 1500, 1788.)
Günther Cat. VIII, p. 428.
Figured, M'Coy, Prodr. Zool. Vict., pl. 144.
Loc.—One specimen from Portland, M'Coy, l.c.

FAMILY RHINIDÆ.

RHINA, Klein.

R. squatina, L. Syst. Nat. I, p. 398.
Günther Cat. VIII, p. 430; Macleay Cat. 1103.
Figured, M'Coy, Prodr. Zool. Vict., pl. 34.
Loc.—Not very uncommon in Hobson's Bay and around our coasts, M'Coy, l.c.
Vernacular name—*Angel Fish.*

FAMILY PRISTIOPHORIDÆ.

PRISTIOPHORUS, Muller and Henle.

P. nudipinnis, Günther Cat. VIII, p. 432, 1870.
Günther Cat. VIII, p. 432; Macleay Cat. 1105
Figured, M'Coy, Prodr. Zool. Vict., pl. 56.
Loc.—*Passim.*
Vernacular name—*Saw-fish.*

FAMILY SELACHIDÆ.

(CETORHINUS, De Blainville.)

(*C. maximus*, Günner, Trondj. Selsk. Skrift, III, p. 33, 1765.)
Günther Cat. VIII, p. 394; Macleay Cat. Sup. 1285.
Figured, M'Coy, Prodr. Zool. Vict., pl. 104.
Loc.—One specimen, Portland, M'Coy, l.c.
Vernacular name—*Basking Shark.*

FAMILY RHINOBATIDÆ.

TRYGONORHINA, Muller and Henle.

T. fasciata, Muller and Henle, p. 124.
Günther Cat. VIII, p. 448; Macleay Cat. 1111.
Figured, Muller and Henle, pl. 43.
Loc.—"Common in S. part of Port Phillip," J. Bracebridge Wilson.
Vernacular name—*Fiddler Ray.*

FAMILY TORPEDINIDÆ.

NARCINE, Henle.

N. tasmaniensis, Richardson, T.Z.S. III, p. 178, 1849.
Günther Cat. VIII, p. 452; Macleay Cat. 1112.
Figured T.Z.S. III, pl. 11.
Loc.—One specimen St. Kilda Beach; also in Bass's Straits, Castelnau, P.Z.S. Vict. I, p. 223.

FAMILY RAJIDÆ.

RAJA, Cuvier.

R. lemprieri, Richardson, Voy. Erebus and Terror, p. 43, 1846.
Günther Cat. VIII, p. 463; Macleay Cat. 1114.
Figured, Voyage Erebus and Terror, pl. 23.
Loc.—*Passim.*
Vernacular name—*Thornback Ray.*

(*R. dentata*, Klünzinger, Archiv. f. Naturg. xxxviii, p. 46, 1872.)
Macleay Cat. Sup. 1289.
Loc.—"Port Phillip," Klünzinger, l.c.

R. scabra, Douglas Ogilby, Cat. Fishes in Australian Museum, Part I, 1888.
Macleay Cat. 1115.
Syn.—*R. rostrata*, Castelnau, P.Z.S. Vict. II, p. 57.
Loc.—Port Phillip, Castelnau.

FAMILY TRYGONIDÆ.

UROLOPHUS, Muller and Henle.

U. testaceus, Mull. and Henle, p. 174, 1841.
Günther Cat. VIII, p. 486; Macleay Cat. 1121.
Figured, Mull. and Henle, pl. 56.
Loc.—Port Phillip (Morton, Lucas.)

FAMILY MYLIOBATIDÆ.

MYLIOBATIS, Cuvier.

M. nieuhofii, Cuv. Régne Animal, 1830.
Günther Cal. VIII, p. 491; Macleay Cat. 1123.
Loc.—*Passim.*
Vernacular name—*Eagle Ray, Sting Ray.*

(*M. australis*, Macleay Cat. 1124, 1880.)
Figured, M'Coy, Prodr. Zool. Vict. pl. 63.
Loc.—One specimen Queenscliff, M'Coy, l.c.

SUB-CLASS III.—CYCLOSTOMATA.

FAMILY PETROMYZONTIDÆ.

MORDACIA, Gray.

M. mordax, Richardson, Voy. Erebus and Terror, 1846.
Günther Cat. VIII, p. 507; Macleay Cat. 1127.
Figured, Voy. Erebus and Terror, pl. 38.
Loc.—Lower Yarra, Castelnau, P.Z.S. Vict. I, p. 229.
Vernacular name—*Lamprey.*

(NEOMORDACIA, Castelnau.)

(*N howittii*, Castelnau, P.Z.S. Vict. I, p. 232, 1872.)
Macleay Cat. 1128.
Loc.—One specimen, Cape Schanck, Castelnau, l.c.

GEOTRIA, Gray.

G. australis, Gray, P.Z.S., p. 238, 1851.
Günther Cat. VIII, p. 508; Macleay Cat. 1129.
Loc.—Saltwater R., Castelnau, P.Z.S. Vict. I, p. 227.

(YARRA, Castelnau.)

(*Y. singularis*, Castelnau, P.Z.S. Vict. I, p. 231, 1872.)
Macleay Cat. 1132.
Loc.—One specimen, Lower Yarra, Castelnau, l.c.

SUB-CLASS IV.—LEPTOCARDII.

FAMILY CIRROSTOMI.

BRANCHIOSTOMA, Costa.

B. lanceolatum, Pallas, Spicil. Zool. X, p. 19, 1769.
Günther Cat. VIII, p. 513; Macleay Cat. 1133.
Figured, E. Ray Lankester, Q.J.M.S., 1889.
Loc.—Port Phillip and Western Port (if our species be identical with above).
Vernacular name.—*Lancelet.*

ART. III.—*On the Occurrence of Kraussina lamarckiana, Davidson, at Williamstown, with a Census of the Victorian Brachiopoda.*

By A. H. S. LUCAS, M.A., B.Sc.

[Read April 11, 1888.]

It was with much pleasure that, while searching under the stones, rendered accessible by low tide at Williamstown, for some of the gastropods usually obtained there, I found large numbers of the small brachiopod, *Kraussina lamarckiana*, Davidson. This was in the summer of 1884, and I have usually met with numerous examples in each summer visit to the locality. I am not aware of the species being recorded before as Victorian, but whether or not, have thought it would be of interest to members, to learn of the existence of a species of brachiopod in considerable numbers, in a part of Port Phillip so near to Melbourne.

It will be convenient here, to give a census of the species hitherto recorded from Victorian seas. All belong to the division denominated *Clistenterata*, by King.

ORDER.—BRACHIOPODA.

DIVISION.—CLISTENTERATA.

TEREBRATULINA, D'Orbigny.

T. cancellata, Koch, in Küster's Conchyl. Cat. VI, p. 36, pl. 2B, figs. 11–13.
Figured, Challenger Zoology Report I, pl. 1, figs. 11–16.
Loc.—At or near Port Phillip Heads (J. Bracebridge Wilson, Victorian Naturalist IV, p. 118, 1887); off E. Moncœur I, Bass's Straits (Challenger Zoology Report I, p. 37).

WALDHEIMIA, King.

W. flavescens, Val. apud Lamarck, An. sans Vert. VI, p. 246, 1819.
Syn.—*Ter. australis*, Quoy et Gaimard, 1834.
T. recurva, Quoy et Gaimard, 1834.
T. dentata, Val., 1819.

Figured, Challenger Zoology Report I, pl. 3, figs. 10–12.
Loc.—Western Port abundant; Port Phillip Heads (J. Bracebridge Wilson, Victorian Naturalist IV, p. 118).

MAGASELLA, Dall.

M. cumingi, var *fibula*, Davidson, Challenger Zoology Report I, 1880.
Syn.—*Bouchardia fibula*, Reeve, Conch. I. con., pl. 7, fig. 30, 1861.

Magasella cumingi, Davidson, P.Z.S., p. 78, pl. 14, 1852.
Figured, as above.
Loc.—One specimen only known, British Museum; probably only a very large specimen of *M. cumingi*, and not a *Bouchardia*; from Bass's Sts. (Davidson, l.c.)

MEGERLIA, King.

M. willemoesi, Davidson, P.R.S. XXVII, p. 438, 1878.
Figured, Challenger Zoology Report I, pl. 4, figs. 1–3 (in the plate entitled *Magasella willemoesi* by printer's error).
Loc.—Three or four specimens from off Twofold Bay, N.S.W. (Challenger Report, l.c.)
Dredged by Mr. Bracebridge Wilson, at Port Phillip Heads (Victorian Naturalist IV, p. 118).

KRAUSSINA, Davidson.

K. lamarckiana, Davidson, P.Z.S. p. 80, pl. 14, figs. 22, 23, 1852.
Figured, Challenger Zoology Report, pl. 4, fig. 9.
Loc.—Under stones at low water, Williamstown; from Tasmania, S.E. Australia and New Zealand (Tenison Woods, Census of Marine Shells of Tasmania, 1877).

Art IV.—*Observations on the Australian Species of Peripatus.*

By Arthur Dendy, M. Sc., F.L.S.

[Read July 11, 1889.]

Part I.—Historical—Habitat—Specific Characters—Variation in External Characters.

In the January number of the *Victorian Naturalist*, and also in *Nature* for February 14, 1889, I published a short account of the discovery of two specimens of *Peripatus* at Warburton, on the Upper Yarra, which presented external colour markings so well pronounced, and so different from what had usually been described in the only known Australian species, *P. leuckartii*, that I considered the two specimens as probably belonging to a new species. Mr. Sedgwick, in response to my letter, published a note in *Nature* (February 28, 1889), in which he expressed the opinion that the species probably was subject to considerable range of variation in colour. Since the publication of my first account, I have been in correspondence on the subject with Mr. Fletcher, who is well acquainted with the New South Wales specimens of *Peripatus*, and who most kindly sent me a specimen from his collection, and also copies—some in advance of publication—of his own notes on the subject. Mr. Fletcher also tells me, in a letter dated February 22, 1889, that "the New South Wales specimens of *Peripatus* undoubtedly present very considerable variation in colour and markings, and this is true of specimens from the same locality, whereas specimens from different localities can be very fairly matched." This remark is based upon the examination of a specimen sent by Mr. Olliff to Mr. Sedgwick, a specimen in the Australian Museum, and nine specimens in Mr. Fletcher's own collection, which were all that were known at the time he wrote.

A few weeks ago, my friends, Mr. Edward Nye and Mr. D. Avery, of Queen's College, Melbourne University discovered, after much patient searching, eleven specimen of *Peripatus* at Brown Hill, in the vicinity of Ballara

which they kindly placed at my disposal in a living and healthy condition. From the examination of these specimens, I have been able to gain a fairly good idea of the extent of variation in colour markings which the species undergoes; and also to make some observations on the internal anatomy. I have come to the conclusion that there is only one Australian species yet known, and the present appears to me to be a good opportunity for bringing together our scattered knowledge concerning it, and recording my own observations. The anatomical part of my paper is not yet ready, although I have already carefully studied the anatomy, by means of dissection and serial sections, but I hope to publish it at a future date, and also to be able to give an account of the development.

HISTORY OF OUR KNOWLEDGE OF PERIPATUS LEUCKARTII.

The species was originally described by Saenger, in 1869. I have not been able to see the original paper, but Sedgwick gives the title as follows:—"Description of a *Peripatus* from Australia," "Transactions of the Russian Assembly of Naturalists," held at Moscow in 1867, Moscow, 1869 (Russian).

This paper was preceded by a preliminary account by the same author, as I learn from the *Archiv für Naturgeschichte* (*Jahrgang* 35, Band 2, p. 277), in which Leuckart, in his "Bericht üb. d. Leist. in d. Naturgeschichte der niederen Thiere während der J. 1868–69," remarks:—"*Onychophori.* Der seit Grube (1853) nicht wieder untersuchte Peripatus wird auf Anregung des Ref. von Saenger zum Gengenstand einer anatomischen Untersuchung gemacht, deren Hauptresultate vorläufig in den Protocollen der Moskauer Naturforscherversammlung mitgetheilt sind." A brief abstract of the paper then follows.

Saenger's complete paper is also noticed in the *Archiv für Naturgeschichte* (Jahrgang 37, Band 2, p. 406.) The notice runs as follows:—"*Onychophori.* Sänger's Untersuchungen über 'Peripatus capensis Gr. und P. Leuckartii,' die wir nach einer vorläufigen Mittheilung schon im letzten Jahresberichte anzogen, sind in den Verhandlungen der Moskauer Naturforscherversammlung, Abth. Zoologie S. 237–262. Tab. XII u. XIII inzwischen ausführlich veröffentlicht. Die neue Art, die aus Neu-Holland stammt, wird folgendermaassen beschrieben: Fünfzehn Paar Fusstummel, von denen das letzte Paar die Geschlechtsöffnung zwischen sich nimmt.

Auf der Unterseite der Füsse drei Erhebungen, von denen die eine lang und bogenförmig ist, während die zwei andern kurz und gerade sind. Länge 21 Mm., grösste Breite 3·05 Mm."

In 1887, Mr. Henry Tryon published an interesting paper "On *Peripatus* and its Occurrence in Australia," in the "Proceedings of the Royal Society of Queensland" (Vol. IV., p. 78). In this paper he announces the re-discovery of *Peripatus* in Australia, and gives a brief account of its structure, habits, and distribution, and to this paper I would especially call the attention of Australian naturalists. In 1886, Mr. Tryon found two specimens of *Peripatus* in a collection of invertebrata from the Cardwell district, sent to the Queensland Museum. These specimens were unfortunately lost in Sydney. A single specimen of *Peripatus* was next found by Mr. Tryon under dead wood in a gully in Victoria Park, Brisbane; and later on several specimens were obtained under stones within a short distance of the General Hospital. The author points out the great resemblance between the Australian and New Zealand species. He likewise observed the important fact that "the external jaw claw is simple, with a slight elevation at the base of the claw proper"; but he did not recognise this character as a distinction between the Australian and New Zealand species, as was subsequently done by Sedgwick.

Concerning the colouration of the body, Mr. Tryon says the species "exhibits the same variation in colouring which occurs in the different species of the genus. . . . The Australian species is very dark blue, almost black, with a few rust-like specs here and there, and lighter coloured beneath; or dark fuscous, with a still darker line along the back."

In the *Annals and Magazine of Natural History* for September of the same year (1887), Professor F. Jeffrey Bell published a very brief note (p. 252) on the "Habitat of *Peripatus Leuckarti*," in which he says:—"Dr. E. P. Ramsay, F.R.S.E., has lately been so kind as to send me two specimens of *Peripatus Leuckarti*, Sänger. Professor Leuckart's only information with regard to the place of origin of his specimen was 'Neu Holland.' It may therefore be of interest to state that Mr. Ramsay's examples were taken in the Queensland Scrubs, near Wide Bay."

The next discovery of *Peripatus leuckartii* took place in Victoria, and is recorded by Mr. Fletcher in the "Proceedings of the Linnean Society of New South Wales" (Vol. II.,

Part I., 1887). Mr. Fletcher observes:—"The specimen which I exhibit this evening was given to me a fortnight ago by my friend Mr. R. T. Baker, of Newington College, who had obtained it a few days previously either in or under a rotten log at Warragul, Gippsland, Victoria. It has fifteen pairs of claw-bearing appendages, and has nearly the same dimensions as are given in the abstract referred to. It is, therefore, in all probability an example of *P. Leuckartii*, Sänger." The specimen was received by Mr. Fletcher in a dried-up condition, so that he was not able to make any further observations upon it.

At a meeting of the Linnean Society of New South Wales, on November 27, 1887, Mr. A. Sidney Olliff exhibited and read a note upon a specimen of *Peripatus leuckartii* which had been obtained by himself and Mr. H. Merewether at the foot of a grey gum tree at Cassilis, on the banks of the Mounmoura Creek, a tributary of the Goulburn River. This is the first recorded discovery of *Peripatus* in New South Wales. Mr. Olliff says in his note:—"During life my specimen was coloured as follows:—Shining slaty-brown above, dusted with brick-red, with a dusky-red patch on the head, and a moderately distinct dusky-red lateral line on each side extending throughout its entire length; below, pinkish grey; the antennæ dark brown. It measured 21 mm. when fully extended."

In April 1888, Mr. Sedgwick's beautiful "Monograph on the Species and Distribution of the Genus *Peripatus* (Guilding)" was published in the *Quarterly Journal of Microscopical Science*. The author's observations on *P. leuckartii* were confined to the two specimens sent by Mr. Ramsay to Professor Bell, and the only locality which he gives for the species is "near Wide Bay, Queensland." The species is diagnosed as follows:—"Australasian Peripatus, with fifteen pairs of legs, an accessory tooth on the outer blade of the jaw, and a white papilla on the ventral side of the last leg of the male." Professor Bell's two specimens are described, and a few anatomical details are given. The species is not figured.

At the meeting of the Linnean Society of New South Wales of June 27th, 1888, Mr. Fletcher exhibited and described seven more specimens of *Peripatus*, obtained on a country road near Wollongong, New South Wales. Three of the specimens he preserved alive, and he gives a detailed account of the size and colouration of these.

On October 31, 1888, the same author exhibited some young specimens, the progeny of one of the three exhibited at the last meeting. The size and colouration of these young specimens (four in number) is briefly noted.

On November 28, 1888, again, Mr. Fletcher exhibited at the same Society's meeting two living specimens of *Peripatus leuckartii* from Burrawang, County of Camden, and their general colouration is briefly noted.

Peripatus leuckartii was next met with again by myself in Victoria; from which colony, it will be remembered, it was hitherto represented only by a single dried-up specimen from Gippsland. In December last, I found two specimens in a fern-tree gully at Warburton, on the Upper Yarra; and I recorded the discovery, with a brief account of the specimens, in the *Victorian Naturalist* and *Nature* (*locc. citt.*). Owing to the very distinct and definite markings on both of my specimens, I thought that they would probably prove to belong to a species distinct from *P. leuckartii*. Subsequent research, however, has shown that this is not the case.

Finally, the latest literature on the subject is a short letter in *Nature*, by Mr. A. Sedgwick, F.R.S., in reply to my own, in which he says:—"The Victorian and New South Wales localities are recorded in a postscript appended to my monograph of the genus as reprinted from vol. iv. of the "Studies from the Morphological Laboratory of the University of Cambridge." . . . . . The New South Wales species is, I think, identical with that found in Queensland, and I should be inclined to doubt the distinctness of the Victorian species recorded by Mr. Dendy in *Nature* (p. 366), and previously by Mr. Fletcher. Mr. Dendy appears to lay some stress on the differences of colour as between his specimen and the specimens of *P. leuckarti* hitherto described, but it must be remembered that in some species of Peripatus—*e.g. capensis* and *novæ-zealandiæ*—the range of individual colour-variation is very considerable." Mr. Sedgwick concludes—"Its development cannot fail to be of the greatest interest, and it is sincerely to be hoped that the Australian zoologists will lose no time in working it out."

In the present paper, as already mentioned, I have to record the discovery of eleven more specimens of *Peripatus* in Victoria, obtained by Messrs. Nye and Avery (of Queen's College), at Brown Hill, near Ballarat. The examination of these specimens leaves no doubt as to the correctness of

Mr. Sedgwick's views as to the specific identity of all the Australian specimens.

Habitat of Peripatus leuckartii.

The animal is generally found beneath either stones or logs—either in open places, or in sheltered ones, such as gullies. They appear to be more frequently met with under stones than in any other situation. The first Victorian specimen was found either in or under a rotten log at Warragul, and the two which I found were both under logs, in a fern-tree gully at Warburton. The animals obtained by Messrs. Nye and Avery were, however, nearly all found under stones, and those gentlemen have kindly furnished me with the following note concerning the habitat of their specimens:—

"Whilst out on an expedition at Brown Hill in the vicinity of Ballarat, in turning over some large silurian stones, we found a *Peripatus* beneath one sunk an inch or so into the earth. On subsequent expeditions, we found ten more—nine of them beneath silurian stones—some under large, and some under small stones, some being sunk in moss and grass, and some lying in bare spots almost devoid of vegetation. The greater part of the range where the *Peripati* were found is bare, and covered with silurian sandstone; further on, it becomes covered with scrubby gum trees, about six to ten feet high, and over-grown with mosses and lichens. Here we found only two.

All these *Peripati* were found beneath silurian, and though quartz and granite were plentiful, in no case did we find any beneath them. Sometimes the *Peripati* were beneath the stones, sometimes clinging to them, and again, in the rubbish around them.

"In one case only did we find two beneath the same stone, and they were small ones. The blue and bluish-brown ones were found in a spot covered with more vegetation and bracken.

"We searched the foot of this range for about a mile and a half here, and then proceeded a couple of miles further along to a part better timbered. Here we found two—one beneath a decaying log, and the other beneath a silurian stone in an open spot. There were few fallen logs, so we had little chance to look for *Peripati* beneath them.

"The range is about three miles N.E. of Ballarat, and runs about east and west, so that the *Peripati* were found

at the foot of the south side. A small creek runs along the foot of the range."

SPECIFIC CHARACTERS OF PERIPATUS LEUCKARTII.

I have already quoted Sedgwick's definition of the species—"Australasian Peripatus, with fifteen pairs of legs, an accessory tooth on the outer blade of the jaw, and a white papilla on the ventral side of the last leg of the male." This author states that, after careful search, he has only been able to find three minute points of real difference between the Australian species *(P. leuckartii)* and the New Zealand species (*P. novæ-zealandiæ.*) These are:—

"(1) The outer blades of the jaws have an accessory tooth at the base of the main tooth, as in the Cape species.

"(2) The male has a rounded white papilla on the ventral face of the fifteenth leg, on each side of the genital opening. It is in the same position with regard to the leg as the corresponding structure in the Cape males.

"(3) The pigment on the ventral surface is much less conspicuous in this than in the New Zealand species, so that the mottled appearance presented by the ventral surface of the latter species is not found in these specimens. The pigment on the ventral surface of these specimens is much more marked in the lower parts of the papillæ than elsewhere. In the skin between the papillæ and at the apices of the papillæ the pigment is so faint as to be hardly discernible. The result is that to the naked eye the ventral surface appears quite pale with coloured papillæ projecting from it. The predominant pigment of the ventral surface is the blue, but orange is present. The hind end of the ventral surface in the region of the last three legs is darker than elsewhere, in consequence of the great number of the pigmented papillæ.

"In addition to the above characters, it may be mentioned that the genital papilla of the female is remarkably prominent, and bears at its free end a longitudinally disposed slit. In the male the genital papilla is fairly prominent, but its aperture is wider and more rounded, resembling the same structure in both sexes of the New Zealand species."

The presence of an accessory tooth on the outer blade of the jaw, and of a white papilla on the ventral surface of the fifteenth leg of the male;* and the prominence of the

* I have only seen one small male specimen; which I judge to be a male from the presence of the white papillæ, as mentioned, and the less prominent genital papilla (*vide* description of specimen *i*).

genital papilla in the female, are all characters of the Victorian specimens examined by me.

The third diagnostic character given by Sedgwick, however—namely, that concerning the colouration of the ventral surface, and the absence of a mottled appearance therefrom—no longer holds good, as will be seen later on, from the description of the colouration of the Victorian specimens.

Concerning the external anatomy Sedgwick also mentions the following points, all of which I am able to confirm in the case of Victorian specimens:—"The genital papilla . . . is between the legs of the fifteenth pair. The feet and legs resemble exactly, so far as could be made out, those of the New Zealand species. The feet have the median dorsal papilla so characteristic of that species; there are three pads on the legs, and a patch of blue pigment round the opening of the nephridia."

It is, perhaps, still doubtful whether any constant specific characters can be derived from the colouration of *Peripatus leuckartii*, but in the next section of my paper I shall endeavour to show that the colour and markings, however they may vary, are in all cases deducible from a typical and characteristic pattern.

Variation in Size and Colour Markings of Peripatus leuckartii.

The variation in size and colouration of the species is amply illustrated by the thirteen Victorian specimens which I have been able to examine in the living condition, and I shall therefore confine my description to these. As I have already pointed out, Mr. Tryon, Mr. Olliff, and Mr. Fletcher have also given some account of the colouration of their specimens, which seem to agree with one or other of the Victorian ones. The size of the specimens probably depends principally upon their age.

The following is a brief account of the Victorian specimens. It will be seen that they form a series with two extremes—(1) the red, and (2) the blue (which becomes so dark as to appear black when the specimen is examined as an opaque object). I will begin with the red specimens:—

(a, b) The two specimens obtained at Warburton. The general tint is brownish-red, with only traces in one specimen of the bluish colour. The markings on the body are

singularly distinct and well defined, and identical in the two specimens. All down the dorsal surface there runs a median, broad, reddish-brown or chestnut-coloured band, divided into a series of diamond-shaped patches by regular lateral indentations—one diamond corresponding to each pair of legs. In the middle of this band there is a thin, median, whitish line. On either side, the chestnut-coloured band is edged by a narrow black line, which follows the indentation of its margin; and outside of this comes a broad band of darker brown, and then at the edge of the dorsal surface a narrow band of light brown. The ventral surface is light yellowish-brown, speckled with spots of very dark pigment, especially abundant at the base of each leg. In the mid-ventral line there is a row of white spots, one between the two legs of each pair, except the first (?), and the last, where, of course, the genital opening is situated. The antennæ are light brown, closely ringed all the way up with very dark brown or black. One of these specimens, when crawling, measured thirty-nine millimetres in length.

All the remaining specimens are from near Ballarat, obtained by Messrs. Nye and Avery.

(c) Very much resembles the Warburton specimens.

Dorsal Surface.—General colour, chestnut. The diamond-shaped segmental markings are continuous and very strongly marked, of a rich chestnut-red colour, edged with black shading off into dull red. A thin median white line is present, edged with grey.

Ventral Surface.—Much lighter. General appearance yellowish; spotted with yellow papillæ. There is a dark bluish-black spot at the base of each pair of legs, continued up the leg as a thin line. There is an oblong spot of a light yellowish colour between each pair of legs but the last. The legs are planted on a dark line, and the ventral surface of the legs is pale reddish-yellow. Genital papilla cream-coloured. Antennæ pale reddish-yellow, ringed with bluish-black.

Length, when crawling, thirty millimetres.*

(d) General appearance dark, blackish. Markings as in *c*, but with the red much duller and less conspicious. There is a small light spot at the apex of each triangular half of each diamond-shaped patch on the dorsal surface. These spots appear to be present in most, if not all, specimens where the

* Length always exclusive of antennæ.

diamond markings are visible. The genital papilla is cream-coloured, with a slight orange tinge; and the antennæ are reddish towards the base, and black at the tips.

Length, when crawling, twenty-three millimetres.

(*e*) This specimen was light coloured, and translucent in appearance.

Dorsal Surface.—There is a very strongly-marked continuous band down the middle, formed of a series of segmentally-arranged diamond-shaped patches of pale reddish yellow, edged by light, dull, indigo blue, shading off into pale yellowish red, with dull indigo blue papillæ. A thin median light line is just visible.

Ventral Surface.—Lighter. Pale, dull bluish, with a row of pale reddish-yellow areas, one between each pair of legs. A dark patch at the base of each leg continued up the leg for a little distance as a thin stripe. Ventral surface of legs pale reddish-yellow. The legs are planted on a darker stripe of dull indigo blue. Genital papilla, orange. Antennæ, pale reddish-yellow, ringed with dull indigo blue.

Length, when crawling, twenty-two millimetres.

(*f*) This was a very young specimen. It had apparently just died, but was in a perfectly fresh condition, when I came to examine it. Its general appearance was dark.

Dorsal Surface.—Dark, dull blackish, with a thin median lighter bluish line, with brownish-red papillæ so disposed as to form segmentally-arranged diamond-shaped patches, one over each pair of legs, as usual.

Ventral Surface.—Dull blackish, with a tinge of indigo blue; thickly spotted with greyish-yellow papillæ. There is a median row of lighter, brownish-grey areas, one between each pair of legs but the last. Genital papilla, orange. Ventral surface of legs chiefly reddish-yellow. Antennæ black.

Length, when lying still, seven millimetres.

(*g*) *Dorsal Surface.*—General appearance almost black, dull, with a slight dull reddish tinge. A very thin, light median line, edged with black, is scarcely visible. Segmentally-arranged diamond-shaped patches, one over each pair of legs, are faintly indicated as redder splotches, each divided into two triangular lateral areas edged with black.

Ventral Surface.—General appearance light reddish, with yellowish papillæ. There is an elongated lighter spot between each pair of legs but the last; and there are dark

spots at the base of each leg, each continued some way up the leg as a thin, dark stripe. Ventral surface of legs pale yellowish-grey, with perhaps a dull bluish tinge. Genital papilla, orange. Antennæ grey, ringed with black.

Length, when crawling, thirty millimetres.

(h) General appearance dark, blackish.

Dorsal Surface.—Dull black, with tinges of indigo blue and red, and with the faintest possible indications of diamond-shaped markings. A thin median lighter stripe is present.

Ventral Surface.—Paler. Blackish, with a reddish tinge and pale yellow papillæ. There is a dark patch at the base of each leg, continued up the leg as a fine stripe, and a pale reddish spot, divided transversely into two halves, between each pair of legs but the last. Ventral surface of legs pale yellowish-red. Genital papilla, orange. Antennæ yellowish-grey, ringed with black.

Length, when crawling, thirty-two millimetres.

(i) This was a small specimen, which died just before I came to examine it in detail, possibly from too much handling. There is a small white papilla on the ventral surface of each leg of the last pair, on each side of the genital aperture, and the genital papilla is less prominent than usual; hence the specimen is doubtless a male. It presented a peculiar character, which I have noticed in no other case, namely, that the eyes were bright red.

Dorsal Surface.—General colour dull indigo blue, rather pale. There is a median, thin, white line; with a row of yellowish spots on each side of it, placed one over each leg and each formed of a single papilla. There is a lighter band of blue over the rows of legs, which are themselves planted on a darker line.

Ventral Surface.—Paler blue, with light yellowish papillæ. A row of median light yellowish spots, one to each pair of legs, and a darker patch at the base of each leg as usual Ventral surface of legs pale yellowish, with a blue tinge Genital papilla, cream-coloured.

Length, in spirit, ten millimetres.

(k) Dorsal Surface.—General appearance black, with a greenish tinge, especially pronounced on the antennæ. A thin median light line is present, and on each side of it a row of small, pale red spots, one over each leg, and each, apparently, consisting of a single papilla.

Ventral Surface.—Grey, with pale yellow papillæ, and, perhaps, a tinge of bluish. A median row of yellowish spots as usual, and also a darker patch at the base of each leg, continued up the leg as a thin dark line. The ventral surface of the legs is pale yellowish towards the apex, and the genital papilla pale orange.

Length, when crawling, twenty-four millimetres.

(l) Dorsal Surface.—As in *k*, with identical markings.

Ventral Surface.—Paler, with same markings as in *k*, but more greenish-blue. Genital papilla, cream-coloured.

Length, when lying still (dead?), ten millimetres.

(m) This specimen was killed, apparently by having the secretion from the oral papillæ of another specimen ejected over it.

Dorsal Surface.—General appearance black, with a thin median light line, as usual. The diamond-shaped patches are represented, as in the last described specimens, by a row of light red spots down each side.

Ventral Surface.—Paler. Blackish, with pale yellow papillæ scattered over it. A median row of lighter yellowish spots present as usual.

Length (dead) seven millimetres.

(n) Dorsal Surface.—Black, with a median thin light line and a row of red spots down each side, one over each leg.

Ventral Surface.—Black, spotted with pale yellow papillæ. A median row of lighter grey patches, one between each pair of legs. Ventral surfaces of legs yellowish-grey. Genital papilla, yellowish-grey.

Length, when lying still (dead?), seven millimetres.

From these descriptions, it appears that the following are more or less constant characters of the species with regard to colour and markings:—

(1) The predominant colours are red and indigo blue—the former passing into yellow, and the latter into black in some specimens.

(2) There is a thin median light line down the dorsal surface.

(3) The characteristic pattern on the remainder of the dorsal surface is a series of segmentally-arranged diamond-shaped patches, in which the red colour is

predominant. In some cases, viz., the darkest specimens, these patches are represented only by a row of small, light coloured, yellow or red spots on each side of the middle line. Each of these spots is situate in the position of the apex of each triangular half of one of the characteristic diamond-shaped patches found in other specimens.

(4) The ventral surface is lighter than the dorsal.

(5) There is on the ventral surface a median row of spots or areas usually paler than the rest of the surface, placed one between the legs of each pair but the last.

(6) At the base of each leg, around the aperture of the nephridium, there is a dark patch of indigo blue.

Whether or not the red colour of the eyes of the male will prove to be a constant character, I am unable to say, as I have only seen one male specimen as yet.

It will be seen, by reference to Mr. Sedgwick's beautiful illustrations, that the pattern on the ventral surface of *P. novæ-zealandiæ* is essentially the same as in *P. leuckartii;* while on the dorsal surface it appears to be very different, though the thin median light line is present in both species.

Mr. Fletcher tells me that he is inclined to think that the median dorsal white line (which is mentioned by Mr. Sedgwick as occurring in the Australian species) is a post-mortem character, due to imperfect preservation, as he has recently examined three moderately well preserved specimens from Queensland (probably from the same locality as Mr. Sedgwick's examples), and these have a distinct dorsal median dark line. Concerning his own Victorian specimen, Mr. Fletcher also says, in one of his published notes:—"A whitish median dorsal line visible in part of the body only is evidently due to bleaching, though in the rest of its course a nodose black line is not well defined." I cannot agree with Mr. Fletcher's views on this point. I have already pointed out that the white line is very thin, and sometimes edged by a dark line on each side. The white line might, I believe, be hidden by contraction in spirit specimens, and the presence of the dark lines edging it may account for the median dark line described by Mr. Fletcher.

ART. VI.—*On some additions to the Fish Fauna of Victoria.*

By A. H. S. LUCAS, M.A., B.Sc.

[Read April 11, 1889.]

1. *Ostracion (Aracana) lenticularis*, Richardson, P.Z.S. p. 21, 1841.

   Günther Cat. VIII, p. 268; Macleay Cat. 1038.

   Loc.—I had a single specimen forwarded to me in 1884, which had been thrown up on the beach of Phillip Island. The length of the specimen is about 220 mm.

2. *Chilobranchus rufus*, Macleay Cat. 909, 1881.

   This species was dredged freely by Mr. J. Bracebridge Wilson, in the Summer of 1887–8, at several stations near the Heads, including Simon's Channel, Limeburner's Channel, Capel Sound, and the Pinnace Channel. Macleay described it from Port Jackson and Tasmanian specimens. I submitted some of our forms to him, and he confirms my identification. It is often met with at Cheltenham.

3. *Stichærium dorsale*, Günther, A.M.N.H. xx, p. 63, 1867; Macleay Cat. 597.

   We dredged this species in numbers in Laverton Bay, in October 1867. It was identified by the Hon. W. Macleay.

Art. VI.—*On a New Species of Bicellaria.*

By J. Bracebridge Wilson, M.A., F.L.S.

[Read April 11, 1889.]

I have to report the occurrence of a new *Bicellaria*, which I found growing on a sponge at Station 1 (off Point Nepean). It is a very minute form, but very beautiful, and is specially interesting from its ringed stem, resembling that of *Stirparia*; and suggesting, if not the identity of, at least the close connection between, the two genera *Bicellaria* and *Stirparia*.

I have handed this new Polyzoon to Dr. P. H. MacGillivray for description and figuring.

Art. VII.—*On some New Species of Marine Mollusca.*

By J. Bracebridge Wilson, M.A., F.L.S.

[Read April 11, 1889.]

The following new species of Marine Mollusca, were dredged in Port Phillip Bay by me in the early part of 1888. The descriptions are by Professor Ralph Tate, F.L.S., F.G.S., and appear in the "Transactions of the Royal Society of South Australia":—

Kellia rostellata spec. nov.—

Shell minute, rather thin, semi-translucent, broadly heart-shaped, a little longer than high, inequilateral and moderately convex. The dorsal margin is oblique on both sides, longer behind than in front, and excavated in front of the beaks.

The ventral margin is rounded and curves upwards to the narrow and subrostrated anterior margin. The umbos are prominent, rather obtuse at the apex, approximate, not curved in front, and situated well in advance of the middle line. The surface is finely and closely concentrically striated; the colour is yellowish horn, umbos and hinge-line brown with a vertical ray of the same colour, increasing in breadth from the umbo to the ventral margin.

Dimensions.—Antero-posterior diameter about 2·5 millimetres; umbo-ventral diameter 2 millimetres; sectional diameter of united valves 2 millimetres.

Locality.—Dredged in life 7 to 9 fathoms, attached to seaweed, Port Phillip Heads, Victoria. J. Bracebridge Wilson.

This species has a general resemblance to *Lascea rubra*, but, apart from the difference of dentition, it is distinguished by its subrostrated anterior side.

Montacuta semiradiata spec. nov.—

Shell minute, transversely ovate, moderately convex; umbos antemedian, thick and rounded; anterior and posterior margins rounded, ventral margin slightly curved outwards, posterior slope gently descending. Surface smooth shining, of a chocolate brown colour, more or less translucent white medially, with a few distant angular threads appearing as pellucid rays, radiating from the umbo to the posterior half of the ventral margin.

Dimensions.—Antero-posterior diameter 2 millimetres; umbo-ventral diameter 1·5 millimetres.

Locality.—Parasitic on *Echinocardium*, East of Mud Island, Port Phillip, in 7 to 10 fathoms. J. Bracebridge Wilson.

Stylifer brunneus spec. nov.—

Shell sub-globose; spire short, acuminately produced; apex cylindrical, styliform; the other whorls are convex, of moderate increase, slightly depressed at the posterior suture; sutures linear. Last whorl large, faintly angulated at the base, and depressed at the suture; and in consequence, having a perceptibly sub-quadrate outline. Outer lip thin, regularly curved, acutely angled posteriorly; columella thin, slightly elevated, defined by a superficial groove behind. Colour

dark brown, shining black-brown around the suture, marked with microscopic crowded obliquely transverse lines, and with distant spiral lines. Animal with a large expanded disk-like mantle.

Dimensions.—Length 5 millimetres; breadth 3·5 millimetres.

Locality.—Parasitic on *Strongylocentrotus*, invariably on the periproct in 8 to 10 fathoms, Capel Sound, Port Phillip. J. Bracebridge Wilson.

This new species resembles in its squat shape *S. Turtoni*, *S. astericola*, *S. ovoideus*, and *S. dubia*; but it has not the insinuated outer lip, obtusely-angled posteriorly of those species. In its regular curved outer lip and general shape it agrees with *S. Stimpsoni* Verrill, and *S. Orbignyanus* Hupe; but the more rapidly enlarging whorls and sub-quadrate last whorl distinguish it from them.

Umbrella corticalis spec. nov.—

Shell orbicular in outline, moderately elevated, with the apex prominent, somewhat incurved and a little excentric; covered, except apex, with a well developed epidermis, which extends about half as far again as the shell. The epidermis is raised into about 20 broad rays, diverging from the apex, and is concentrically lamellose. It is pellucid white, but encircled with a band of maroon colour, corresponding with the edge of the shell; it is very tough, and can be readily removed in one piece. The shell is of a primrose yellow colour, thin, concentrically striated, and with a few obscure radial ridges. The animal is of a deep port wine colour; the foot is circular in outline, with an extended margin; the under side of the mantle is covered with small white carunculæ.

Dimensions.—Transverse diameters 19 and 15 millimetres; height 4 millimetres.

Locality.—Lower end of the South Channel of Port Phillip, 7 to 16 fathoms, sand and weed. J. Bracebridge Wilson.

Lobiger Wilsoni spec. nov.—

Animal with the body produced into a very narrow pointed smooth tail, of a green colour, shortly extended beyond the shell. Foot with two oblong rounded and pale green lobes, which are somewhat attenuated into a broadish

stalk. Shell thin, flexible, straw-yellow; spire rudimentary, but involute; somewhat pyriform, slightly attenuated in front, and truncated apically; aperture narrow ovate, truncate behind. Surface finely striated.

Dimensions.—Length 8 millimetres; width 5 millimetres.

Locality.—Lower end of the South Channel of Port Phillip, 7 to 16 fathoms. J. Bracebridge Wilson.

Besides the above, there is an *Emarginula*, which appears to be new, but which Professor Tate has not yet described. This is a very small but very beautiful species, bright rose-red in the living state. It occurs in the South Channel, (Station 9), and Capel Sound (Station 10).

Kellia rostellata is found abundantly at Station 1, attached by means of a small byssus to seaweed. It is also met with less commonly at Stations 3, 5, and 8.

Montacuta semiradiata has, as yet, only been seen by me at Station 14, but I presume it is likely to occur at other stations where its host, the *Echinocardium*, is common.

Stylifer brunneus has been collected by me only at Station 10. As stated by me, when handing it to Professor Tate, it occurs as a rule only on the periproct of the common *Strongylocentrotus*. I have this season observed one instance of an individual straying away among the spines. Clumps of eggs frequently occur, presumably those of *Stylifer*, among the spines surrounding the periproct.

Of *Umbrella corticalis* and *Lobiger Wilsoni*, I have not as yet been fortunate enough to collect any specimens this year.

ART. VIII.—*Remarks on some New Tables for Finding Heights by the Barometer.*

By E. J. WHITE, F.R.A.S.

[Read May 9, 1889.]

Since the memorable 19th of September, 1648, when the celebrated Pascal ascended the Puy de Dome, in the French Province of Auvergne, and found, as he had anticipated, that the mercury in his barometer fell as he rose, the barometric method of measuring heights has been extensively used, and in many instances, it is the only one available. Until about thirty years ago, only mercurial barometers were used for this purpose. They are still the most accurate, and should always be employed where the utmost precision of this method of measuring is required, but they have the disadvantage of being expensive, bulky, and fragile. At the period mentioned above, the aneroid, which had been invented in 1850 by M. Vidi, came into general use, and of late years it has become so popular, that as a weather-glass, or tourist's companion for measuring elevations, it has nearly superseded the tube of mercury. Almost the sole reason for this preference, is its portability; good aneroids are made that will go into the waistcoat pocket, while others are small enough to be used as charms to be suspended from the watch chain; these latter, however, are to be considered more as trinkets than as philosophical instruments. On the other hand, it is not an independent instrument, but has to have its scale originally marked off, and its errors from time to time found, from comparison with the mercurial barometer, than which it is also more complicated and less stable.

The mathematical part of the subject has been treated by many eminent writers; but since the time of Laplace, his formula has formed the basis of the investigations. If air was an incompressible fluid like water, the law would be very simple; the pressures would be proportional to the

heights, and if its density was throughout the same as at the surface of the earth, it would be all contained within a limit of about five miles. Air, however, is an elastic fluid, subject to Mariotte's law, and has therefore its density proportional to the pressure to which it is subjected, and if there were no disturbing elements, the law would still be a simple one. The heights would be in arithmetical progression, while the pressures would be in geometrical progression, thus having the nature of a table of logarithms, and the difference in height would be equal to a certain constant distance, multiplied by the difference between the logarithms of the heights of the barometer at the two places. The principal disturbing element is temperature, which varies the density of the air by its changes. If we could obtain the temperature of the column of air between the two places, the proper correction could be obtained; but as we can only apply the thermometer to the air near the surface of the earth, where it is greatly affected by radiation, and have to assume, as Laplace has done, that the temperature of the column of air between the two stations is the mean of that near the ground at each station, we sometimes get very anomalous results. This has been proved by observing barometers at two stations, not very distant, though considerably differing in altitude, whose difference of height had been well determined by careful levelling. Having now the height and the barometer readings, we can substitute them in Laplace's formula, and work out the temperatures. An extensive series of such observations was made by Professor Plantamour, using for his stations, Geneva and the Hospice of St. Bernard. From the mean of the 8 a.m. observations, the correction to the observed mean temperature varied from $+4{\cdot}5°$ in December to $-4{\cdot}3°$ in July. The 4 p.m. observations gave $+2{\cdot}3°$ in December, and $-6{\cdot}5°$ in July, and the 10 p.m. observations had a range of from $+4{\cdot}7°$ in December to $-0{\cdot}2°$ in July. Similar observations in the United States, between Mount Washington in New Hampshire and Portland, Maine, gave the following ranges: 8 a.m., $+1{\cdot}7°$ in August, and $-1{\cdot}9°$ in November; 5 p.m., $-3{\cdot}2°$ in December, and $-1{\cdot}1°$ in September; and 11 p.m., $+3{\cdot}4°$ in August, and $-2{\cdot}1°$ in November. As the effect of an error of one degree in the mean temperature is about 2 feet in 1000, the greatest of the above corrections, the $-6{\cdot}5°$ in July, would amount to 13 feet in 1000. Attempts have been made to determine the law of decrement of the temperature of the

atmosphere, the results are not very consistent, but it appears to be nearly in an arithmetical progression, Glaisher finding in his 20,000 feet balloon ascent, a decrease of 1° for each 300 feet of ascent. The mean of several observations in Europe and America, is 1° for every 308 feet.

Humidity is another disturbing element: aqueous vapour has only five-eighths of the density of dry air, and does not permanently retain the gaseous form; the hygrometer is, therefore, sometimes used in conjunction with the barometer and thermometer in hypsometry, but as the necessary correction is not well established, it is generally neglected.

The last important source of error is that of gradient. With the air in a state of static equilibrium, two stations at the same height would receive equal pressures; but as a matter of fact, we find that stations at the same level have at the same moment very different pressures, especially if they are distant from one another. Gradients are the result of such complicated conditions, that there is no way of eliminating their effects. We can only mitigate them by taking extensive series of observations, on the supposition, that the effects will thus balance one another in the mean result.

Of the many forms of mercurial barometers, I think the Gay Lussac syphon is best suited for mountain work. It is very compact, not liable to derangement, and eliminates the error of capillarity. The zero point is now usually placed in the middle, so that the sum of the upper and lower readings gives the height of the quicksilver. Of aneroids, the Watkin seems likely to become the favourite for professional work, owing to its very open scale, which, in a four inch instrument, has about seven inches of its outer divisions to denote a variation of one inch of mercury. Ordinary travellers, however, will generally avail themselves of the small instruments, of from about one and a half to two inches diameter, which can be easily carried in the waistcoat pocket, where they are generally much less liable to injury than the larger ones carried on a leather strap. It must be mentioned, however, that no system of barometric measuring will give results nearly approaching those obtained by levelling, or even by the measurement of the vertical angles, where the uncertainty of the refraction is a disturbing element.

From a work issued in 1882 by the Geological Survey Department of the United States, entitled "A New

Method of Measuring Heights by means of the Barometer," by G. K. Gilbert, the following table is given, from the investigation of actual measurements. The assumptions are that one station is 5000 feet higher than the other, that the two places are fifty miles apart, and that they are situated in the temperate zone, remote from the ocean. The observations are supposed to be made near the middle of a fine summer's day, with a light wind blowing:—

	Probable error in feet.	Possible error in feet.
From annual gradient	6	20
,, Diurnal gradient	8	30
,, Non-periodic gradient	20	50
,, Temperature	100	300
,, Moisture	10	20
,, Imperfection of observation ..	10	Unlimited
Totals	103	420 +

It will be noted how largely the temperature error exceeds all the others; and from the second column it will be seen that, excluding the error of observation (which, owing to mistakes, may be unlimited) the total error may amount to 420 feet, or more than one-twelfth of the whole amount measured. The probable error of 10 feet assigned for imperfection of observation is meant for a mercurial barometer; for an aneroid it would be much larger, even when used with the greatest care, and frequently compared with the mercurial column for finding its errors. At our observatory, we have an apparatus for testing mountain and other aneroids. I append the results of some of the late comparisons:—No. 1 has an error of ·09 in a range of 26 to 30 inches. No. 2, ·30 in a range from 23 to 30 inches. No. 3, ·13, range 24 to 30; and ·18, range 23 to 30. No. 4, ·13, range 24 to 30; ·23, range 23 to 30. No. 5 (which is a French barometer metrically divided), ·40, range 25 to 30; and ·63, 24 to 30. In the last three instruments it will be remarked, how the error increases as the extremity of its scale is reached. I have on several occasions, when travelling on our railways, carried an aneroid with me, and recorded its readings, as well as the temperature of the air at stations where we have stopped, and have compared the heights thus deduced with the accurate ones of the railway levels. At first I treated the results as matters of curiosity only, and did not preserve

the records, but I give those I have been able to find. On March 21, 1883, I measured the heights of the following stations on the Sandhurst line, with the French barometer mentioned above. I left Melbourne at 6.45 a.m., the barometer reading 775 millimetres, and temperature of the air 20° centigrade. When I reached Kangaroo Flat at 10.46 a.m. the barometer read 748 millimetres, and the temperature of the air was 24·6° centigrade. The following are the corrections in feet to be applied to the aneriod heights to get the true heights: Sunbury + 26, Lancefield Junction + 105, Gisborne + 50, Macedon — 9, Woodend + 96, Malmsbury — 48, Taradale + 12, Castlemaine + 34, Kangaroo Flat — 34. On May 8 of the present year, I took No. 3 of the above-mentioned barometers along part of the same line. I started at 7 a.m., the barometer reading 30·30 in., and the temperature of the air being 58° Fahr. I reached Macedon at 8.45 ; the barometer reading 28·73, and the temperature of the air 66°. I left Macedon at 5.30 p.m.; barometer 28·65, air 66°, and arrived in Melbourne about 7 p.m.; barometer 30·28, air 62°. Most of my levelling this day was done off the railway, where I had no levels for comparison, but the known heights measured required the following corrections: Gisborne + 154, Macedon (from up readings) + 151, and from the return readings + 86. The above results are not given as specimens of the best method of using the aneroid, but the observations were made with the greatest care. When the mercurial barometer is used, and the stations are in the same vertical, where the error of gradient should be very little, the errors are generally greater than expected. One of the most extensive series of this description was carried out from July 22 to October 15, 1848, by the Royal Engineers employed in the trigonometrical survey of Great Britain. Four mercurial barometers were used, two of these were placed on the top of the dome of St. Paul's Cathedral in London, the other two rested on the floor under the centre of the dome ; after 62 observations had been taken the barometers were transposed, and 89 additional observations were made. The mean of the first set made the height 356·99 feet, and the mean of the second set 353·57, whereas the actual height was 352·75 ; both determinations were therefore in excess of the real amount —the first to the extent of 4·24 feet, and the second to 0·82 feet. Most mountain aneroids are furnished with an altitude scale, either on the same dial as the inch divisions

or on a separate ring which can be set to zero at starting, and thus save the trouble of taking the differences. This latter plan, although more convenient, is not so accurate as the former; but in every case, if the best result is desired, the readings should be taken from the scale of inches or millimetres, as it is uncertain to what temperature the altitude scale is adapted. I have measured some of the English ones, and find the temperatures they represent to vary from 47° to 51°, but the French one mentioned before has its scale adapted to 70° Fahr. The small tables supplied by instrument makers, which have no temperature factor, are generally adapted to about 50°; while the larger tables, which contain the factors for temperature, latitude, and decrease of gravity, are usually given for 32°, the freezing point. The adoption of so low a temperature as 32° is very inconvenient for Australia, where the mean temperature is much higher, as it necessitates a very large correction, and as this correction is frequently neglected, the results must be very inaccurate. I have therefore thought it desirable to compute a new table, in which the mean temperature and middle latitude of this part of Australia should be used. Calling B the height of the barometer, and t the temperature of the air at the lower station, B′ and t′ the same quantities for the upper station, L the latitude, and A the difference of height in feet between the two stations. Laplace's formula, leaving out the factors depending on the decrease of gravity, may be written:

$$A = 60158{\cdot}6\ (\log. B - \log. B') \times \left(\frac{1 + t + t' - 64}{900}\right) 0{\cdot}00265 \cos 2L.$$

Taking now T and T′ equal to 60°, and L = 37°, and substituting them in the above equation, we get

$$A = 63948{\cdot}6\ (\log. B - \log. B').$$

The mean height of the barometer at the Melbourne observatory, 91 feet above the level of the sea, reduced to 32° Fahr., is 29·931 in.; increasing this by 0·07 to bring it up to 60° Fahr., nearly the mean temperature of Melbourne, and by 0·10 to reduce it to sea level, we get 30·10; with this value in the above equation we should find 63948·6 log. B = 94552·26. It would be more convenient, however, to have it represented by o, because the tabulated values corresponding to the height of the barometer will at once show the height above the level

of the sea in Melbourne in the normal state of the atmosphere. This arrangement will have the disadvantage of introducing negative numbers, which will represent depths below the level of the sea, and the quantities will diminish with an increase of the argument, but on the whole, I consider it better than the usual plan. Let now $F = 94552{\cdot}26 - 63948{\cdot}6\ B$, and $F' = 94552{\cdot}56 - 63948{\cdot}6\ B'$, and calling a the height between the two places at the mean adopted temperature, 60°, we have $a = F' - F$. The values of F or F′ are tabulated in the first of the present tables, with the height of the barometer for argument. If a mercurial barometer has been used, the above value of a should be corrected for the difference between the temperatures of the quicksilver at the two stations. If T and T′ represent these temperatures at the lower and upper stations respectively, the correction will be $2{\cdot}5\ (T' - T)$; as T′ is nearly always less than T, this correction will be generally negative.

It will now be necessary to correct a for the actual temperature of the air, calling this corrected value A, we have—

$$A = a + \frac{a}{956{\cdot}7}\ (t + t' - 120)$$

putting $n = 1 + \frac{t+t'-120}{956{\cdot}7}$ we have $A = na$; and the value of n is given in the second table with $t + t'$ as argument. Generally speaking, the value determined from the equation $A = n\ (F' - F)$ will be far within the limits of accuracy of the aneroid barometer; but if it should be thought desirable to apply the small corrections depending on latitude, and decrease of gravity on the vertical, small tables are given for the purpose.

TABLE I.

Argument—Height of Barometer in Inches.

B.	F.	Diff.	B.	F.	Diff.	B.	F.	Diff.
28·0	7471·7		26·0	4066·7		29·0	1034·0	
		120·5			106·6			95·6
·1	7351·2		·1	3960·1		·1	938·4	
		120·0			106·2			95·3
·2	7231·2		·2	3853·9		·2	843·1	
		119·5			105·8			95·0
·3	7111·7		·3	3748·1		·3	748·1	
		118·9			105·4			94·6
·4	6992·8		·4	3642·7		·4	653·5	
		118·4			105·0			94.3
·5	6874·4		·5	3537·7		·5	559·2	
		117·9			104·6			94·0
·6	6756·5		·6	3433·1		·6	465·2	
		117·5			104·2			93·7
·7	6639·0		·7	3328·9		·7	371·5	
		116·9			103·8			93·3
·8	6522·1		·8	3225·1		·8	278·2	
		116·5			103·5			93·1
·9	6405·6		·9	3121·6		·9	185·1	
		115·9			103·0			92·7
24·0	6289·7		27·0	3018·6		30·0	+ 92·4	
		115·5			102·7			92·4
·1	6174·2		·1	2915·9		·1	0·0	
		115·0			102·3			92·1
·2	6059·2		·2	2813·6		·2	− 92·1	
		114·5			101·9			91·8
·3	5944·7		·3	2711·7		·3	− 183·9	
		114·1			101·6			91·5
·4	5830·6		·4	2610·1		·4	− 275·4	
		113·6			101·1			91·2
·5	5717·0		·5	2509·0		·5	− 366·6	
		113·1			100·8			91·0
·6	5603·9		·6	2408·2		·6	− 457·6	
		112·7			100·5			90·6
·7	5491·2		·7	2307·7		·7	− 548·2	
		112·2			100·1			90·3
·8	5379·0		·8	2207·6		·8	− 638·5	
		111·7			99·7			90·0
·9	5267·3		·9	2107·9		·9	− 728·5	
		111·3			99·4			89·7
25·0	5156·0		28·0	2008·5		31·0	− 818·2	
		110·9			99·0			89·5
·1	5045·1		·1	1909·5		·1	− 907·7	
		110·4			98·6			89·1
·2	4934·7		·2	1810·9		·2	− 996·8	
		110·0			98·3			88·9
·3	4824·7		·3	1712·6		·3	− 1085·7	
		109·6			98·0			88·6
·4	4715·1		·4	1614·6		·4	− 1174·3	
		109·1			97·6			88·3
·5	4606·0		·5	1517·0		·5	− 1262·6	
		108·7			97·3			88·0
·6	4497·3		·6	1419·7		·6	− 1350·6	
		108·3			96·9			87·8
·7	4389·0		·7	1322·8		·7	− 1438·4	
		107·8			96·6			87·4
·8	4281·2		·8	1226·2		·8	− 1525·8	
		107·5			96·3			87·3
·9	4173·7		·9	1129·9		·9	− 1613·1	
		107·0			95·9			86·9
26·0	4066·7		29·0	1034·0		32·0	− 1700·0	

TABLE II.

Argument—Sum of Temperatures of Air at both Stations.

$t+t'$	n	$t+t'$	n	$t+t'$	n	$t+t'$	n	$t+t'$	n
50	0·9268	80	0·9582	110	0·9895	140	1·0209	170	1·0522
51	·9279	81	·9592	111	·9906	141	1·0220	171	1·0533
52	·9289	82	·9603	112	·9916	142	1·0230	172	1·0543
53	·9300	83	·9613	113	·9927	143	1·0240	173	1·0553
54	·9310	84	·9624	114	·9937	144	1·0251	174	1·0564
55	·9321	85	·9634	115	·9948	145	1·0261	175	1·0575
56	·9331	86	·9645	116	·9958	146	1·0272	176	1·0585
57	·9341	87	·9655	117	·9969	147	1·0282	177	1·0596
58	·9352	88	·9666	118	·9979	148	1·0293	178	1·0606
59	·9362	89	·9676	119	0·9990	149	1·0303	179	1·0617
60	·9373	90	·9686	120	1·0000	150	1·0314	180	1·0627
61	·9383	91	·9697	121	1·0010	151	1·0324	181	1·0638
62	·9394	92	·9707	122	1·0021	152	1·0334	182	1·0648
63	·9404	93	·9718	123	1·0031	153	1·0345	183	1·0659
64	·9415	94	·9728	124	1·0042	154	1·0355	184	1·0669
65	·9425	95	·9739	125	1·0052	155	1·0366	185	1·0679
66	·9436	96	·9749	126	1·0063	156	1·0376	186	1·0690
67	·9447	97	·9760	127	1·0073	157	1·0387	187	1·0700
68	·9457	98	·9770	128	1·0084	158	1·0397	188	1·0711
69	·9467	99	·9780	129	1·0094	159	1·0408	189	1·0721
70	·9477	100	·9791	130	1·0105	160	1·0418	190	1·0732
71	·9488	101	·9801	131	1·0115	161	1·0429	191	1·0742
72	·9498	102	·9812	132	1·0125	162	1·0439	192	1·0753
73	·9509	103	·9822	133	1·0136	163	1·0449	193	1·0763
74	·9519	104	·9833	134	1·0146	164	1·0460	194	1·0773
75	·9530	105	·9843	135	1·0157	165	1·0470	195	1·0784
76	·9540	106	·9854	136	1·0167	166	1·0481	196	1·0794
77	·9551	107	·9864	137	1·0178	167	1·0491	197	1·0804
78	·9561	108	·9875	138	1·0188	168	1·0502	198	1·0815
79	·9571	109	·9885	139	1·0199	169	1·0512	199	1·0826
80	·9582	110	·9895	140	1·0209	170	1·0522	200	1·0836

Small Corrections, depending on Decrease of Gravity at the Upper Station, Height of the Barometer at the Lower Station, and the Latitude.

		A						
		1000	2000	3000	4000	5000	6000	7000
Decrease of Gravity ..		+2·5	5·2	7·4	10·8	13·7	16·7	19·9
	B.							
Height of Barometer at Lower Station ..	24°	+0·6	1·2	1·8	2·4	3·0	3·6	4·2
	25°	+0·5	1·0	1·5	2·0	2·8	2·9	3·4
	26°	+0·4	0·8	1·2	1·6	2·0	2·3	2·7
	27°	+0·3	0·6	0·9	1·2	1·4	1·7	2·0
	28°	+0·2	0·4	0·6	0·8	0·9	1·1	1·3
	L.							
Latitude ..	20°	+1·3	2·6	3·9	5·2	6·5	7·8	9·1
	25°	+1·0	1·9	2·9	3·9	4·9	5·8	6·8
	30°	+0·6	1·2	1·8	2·4	3·0	3·6	4·2
	35°	+0·2	0·3	0·5	0·7	0·9	1·1	1·2
	40°	−0·3	−0·5	−0·8	−1·1	−1·3	−1·6	−1·9
	45°	−0·7	−1·5	−2·2	−2·9	−3·6	−4·4	−5·1

$$A = n\,(F' - F) + \text{small corrections.}$$

Rule.—Take out the values of F corresponding to the heights of the barometer at the upper and lower stations; take their difference, which in case one of them is negative will be their numerical sum, multiply the difference by the value of n corresponding to the sum of the temperatures of the air at each station; the product A will be very nearly the height in feet of one station above the other. To this value, apply the small corrections for a final result. If the barometer be a mercurial one, a further correction of $2\frac{1}{2}$ feet will have to be subtracted for each degree of excess of the temperature of the mercury at the lower station over that of the upper.

Example.—On May 8, 1889, an aneroid barometer, at the meteorological station near the summit of Mount Macedon, indicated 27·03 in., the temperature of the air being 59°; the same barometer, a few hours after, read at the Melbourne Railway Station 30·23 in., the temperature of the air being 62°. Find the difference of height:—

27·03 in. F =	2987·8	
30·23 in. =	−119·6	
Diff.	3107·4	
	100·1	= n for 121°
	3107·4	
	3·1	
	3110·5	
Small corrections	+ 8·2	
Difference of height ..	3118·7	

ART. IX.—*Notes on the Barometric Measurement of Heights.*

By PROFESSOR KERNOT, M.A., C.E.

[Read June 13, 1889.]

I propose at the present time to submit to the Society a few remarks on the above subject, in connection with the very full and interesting paper given by the Vice-President last month. In that paper the author expressed considerable doubt as to the accuracy of certain statements that had from time to time been made with reference to the high degree of precision with which differences of level can be obtained by means of ordinary aneroids, in the hands of observers whose time is limited, and who are not provided with the costly appliances to be found at a great national observatory. In this view he is certainly not singular, as several of the most experienced and skilful surveyors of my acquaintance have repeatedly made in my hearing very disparaging statements as to these instruments and their performances. Thus, it will be seen that there has been considerable difference of opinion. Some experienced and reliable surveyors speaking of the instrument as being capable of giving differences of level in average cases within five feet, or even less, of the truth; while others regard an error of 100 feet as not only possible, but even probable, under ordinary circumstances. To determine which of these two views is correct, is a matter of great importance from an engineering point of view. If the relative levels of points ten or twenty miles distant can be determined with a probable error of not more than ten, or even twenty feet, the location of roads, railways, and schemes of water supply will be greatly facilitated, as a few hours' work of a solitary observer with the aneroid will often serve, instead of several days' labour of a fully-equipped survey party.

I do not, of course, propose to dispense with accurate levelling in the final or detailed survey of the adopted line. It is in the preliminary investigation and comparison of various possible alternative routes that extreme accuracy is

not needed, while the speed and small cost of aneroid work are so advantageous.

Having taken, on several occasions, the optimistic view in this matter, I felt it desirable to submit some results justifying this opinion. The instruments with which the results I propose to quote were obtained, are the following :—

1. A small compensated aneroid supplied by Kilpatrick and Co., about fifteen years ago. It is a good instrument of its kind, and when tested at the Observatory under the air pump, showed great sensitiveness, the hand responding promptly to the smallest change of pressure. At the same time, I do not suppose it is better than many others that have been exposed for sale by Melbourne opticians.

2. A large open-faced aneroid, not compensated, with a five-inch dial, supplied by the same firm about twenty years ago. This was an exceedingly cheap instrument, but happens to be unusually sensitive, responding to a variation of pressure represented by $\frac{1}{200}$th inch of mercury. This instrument I used many years ago in laying out contour lines on the Geelong waterworks, and found the lines so laid out, when subsequently tested by levelling, to be almost always within three feet of the right level. I should add that I was aided by accurate level marks about fifty feet lower down the slope.

3. A new Watkin aneroid, supplied to the University by Kilpatrick and Co., jewelled and compensated, and having a scale so open that a movement of the index corresponding to $\frac{1}{1000}$th inch of mercury is visible. This instrument is marked No. 161 on the dial.

4. An aneroid barograph marked Kilpatrick and Co., Melbourne, and purchased last year. This instrument keeps a constant record of the pressure of the atmosphere, and as far as I have tested it has worked satisfactorily.

The first experiment that I wish to describe was made about twelve years ago. Four readings were taken with instrument No. 1, on the crest of the dam of the Pipehead reservoir, Geelong Water Works. These readings were taken at intervals of three or four hours, and were compared with simultaneous readings on the mercurial barograph at the Government Observatory, corrections for temperature and for instrumental errors being applied. The true difference of level by levelling was 760 feet, and the distance about forty miles, the intervening country being nearly level and generally devoid of trees. The four

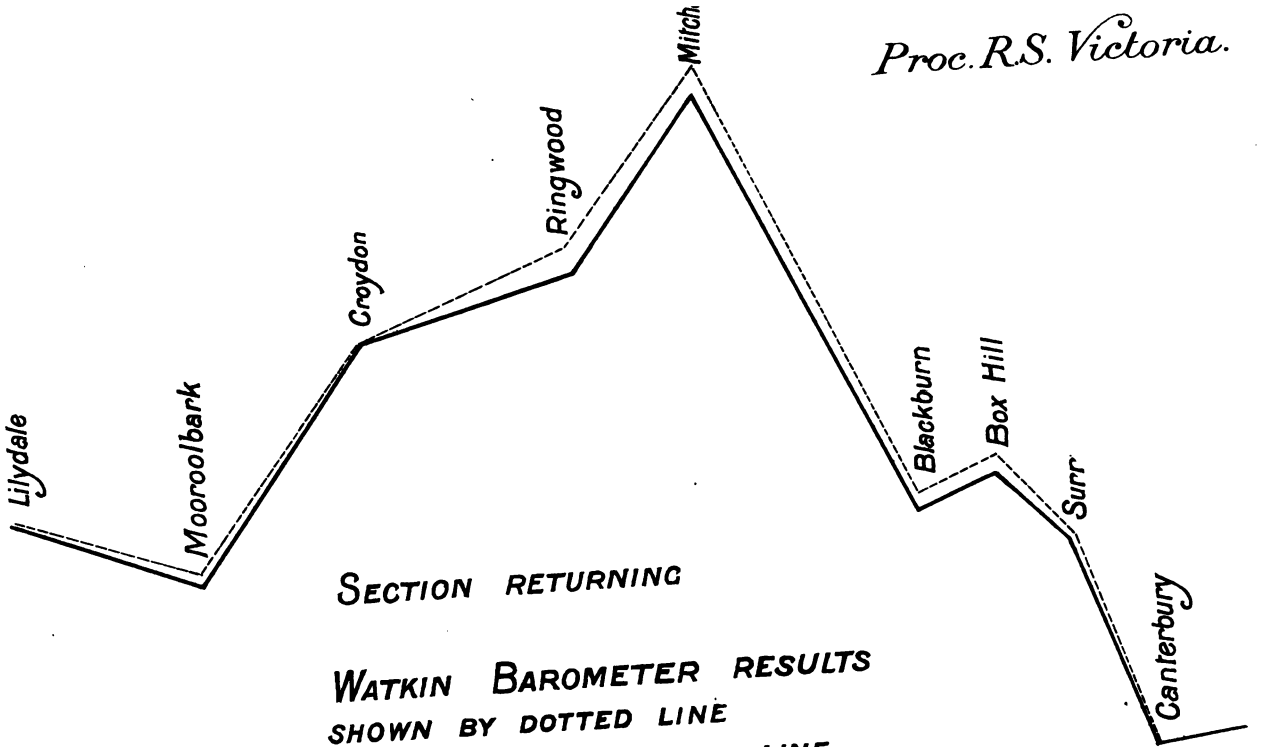
determinations by barometer were all too low, the best being four feet out, the worst eight feet, and the average six feet in error—Laplace's table being used in the calculation.

A second experiment at the same time, consisted in comparing three points within half a mile of the Pipehead dam, and within 100 feet of its level with the dam itself. The level of two of these points was given within two feet of the truth by a single observation, while the third which was not so well observed, owing to night coming on, was five feet in error.

A third experiment which has been frequently performed with the surveying class at the University, consists in taking the height of the gallery on the tower of Ormond College. This is 130 feet from the ground, and has been many times measured by instruments 1 and 2. The result has always been slightly below the truth, usually about 125 feet. I do not remember it ever having been below 120 or above 130.

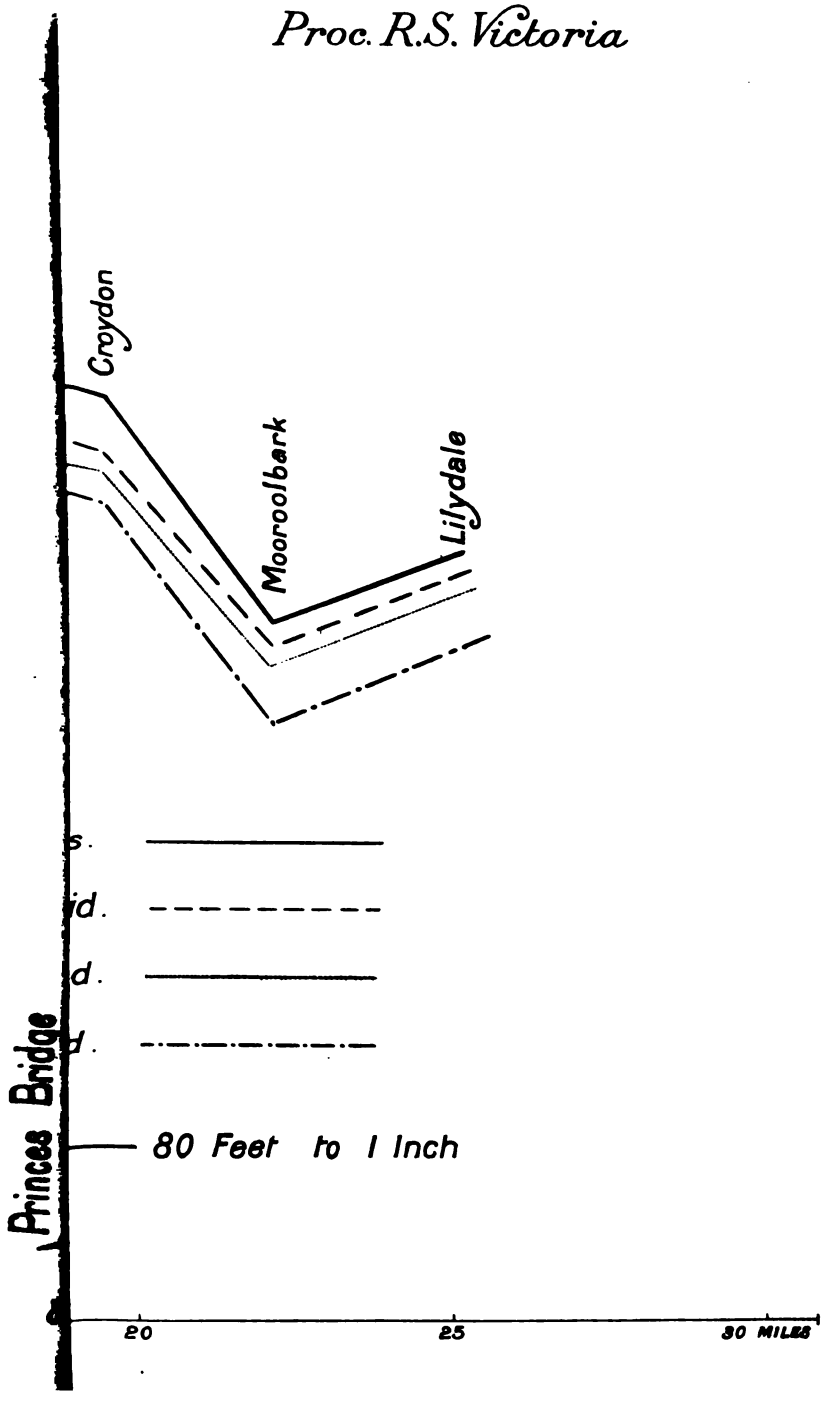
On the 1st inst., having Mr. White's remarks in view, and having for other purposes to pay a visit to a place called Riverview, near the Yarra Glen Railway Station, I determined to make a careful test of the three barometers, and compare the result when fully worked out and all proper corrections applied, with the known difference of level by actual levelling. I therefore set the barograph going at the University, and carefully reading the three instruments at the Princes Bridge Railway Station, took them to Riverview, and read them as other engagements permitted, eight times in forty-eight hours. Thus I obtained twenty-four readings, which, when compared with the Princes Bridge readings, corrected by reference to the barograph and worked out by Laplace's table with instrumental and temperature corrections, gave the following results:—

	Aneroid No. 1.	Aneroid No. 2.	Aneroid No. 3.
	228	222	233·7
	228	240·5	222·0
	238	259	256·1
	228	240·5	236·7
	238	231·2	230·8
	249	231·2	221·7
	228	212·8	213·1
	249	222	222·4
Mean	235·7	232·4	229·6



SECTION RETURNING

WATKIN BAROMETER RESULTS
SHOWN BY DOTTED LINE
RAILWAY LEVELS BY FULL LINE.


Croydon
Mooroolbark
Lilydale
s.
id.
d.
d.
Princes Bridge
80 Feet to 1 Inch
20
25
30 MILES

The true difference of level is 237 feet,* and the distance in a strait line twenty-four miles, the intervening country being rangy and timbered. The worst result by instrument No. 1, is 12 feet in error, the best 1 foot, and the mean 1·3 feet; by No. 2, the worst is 24·2 in error, the best 3·5, and the mean 4·6; by No. 3, the worst is 19·1 in error, the best ·3, and the mean 7·4. The mean of the three means is 4·4 in error.

I also read the instruments at the various stations between Melbourne and Lilydale, and plotted the section of the line from the observations so made. The diagram submitted shows the result. I do not regard this as a fair test, as the readings were hurried, and the instruments had not time to settle. Still the result, especially with No. 3, the Watkin, is fairly consistent and good enough to be of very considerable practical utility.

I think the above experiments will serve as far as they go, to show that barometer work, carried out with fairly good instruments carefully used, and with all proper corrections applied, may be relied upon to give differences of level with greater accuracy than is often supposed, and with sufficient accuracy to be of very great service in preliminary investigations connected with engineering works of various descriptions.

ART. X.—*A New System of Photo-Lithography.*

By G. W. PERRY, ESQ.

[Read June 13, 1889.]

* I have since been informed that this level is not quite accurate.

ART. XI.—*Liquid Kino.*

By J. H. MAIDEN, F.L.S., F.C.S.,

Curator of the Technological Museum, Sydney.

Communicated by BARON FERDINAND VON MUELLER, K.C.M.G., F.R.S., &c.

[Read Thursday, July 11, 1889.]

Angophora intermedia (D.C.), the narrow-leaved apple-tree is a tallish tree, which extends from Victoria to Queensland, and is the only species of the genus which is found in the southern colony. In the following respect, it is perhaps unique amongst Australian trees. Frequently, when an incision is made into the bark, and more particularly when the knobby excrescences sometimes found on this tree are cut, there exudes a watery liquid which occasionally is almost as clear and as colourless as water, and at other times of an orange-brown or reddish-brown colour, and of the consistency of a thin extract, or even as thick as treacle. This is doubtless the substance which was sent from New South Wales to the Paris Exhibition of 1867, labelled "apple-tree juice," with the statement that it is used as a varnish; but this is not correct, as the liquid is aqueous. It is used by fishermen for tanning their nets. Mr. Kirton informed Baron von Mueller that a single tree will yield as much as two gallons of liquid, which is generally called "liquid kino." This is a modest computation, for the tree which yielded the Bangley Creek sample *(infra)* yielded from eight to ten gallons. The quantity is, in any case, by no means small, and is dependent on a variety of circumstances.

Two samples of this "liquid kino" having recently been forwarded to the Technological Museum, the author has had an opportunity of examining it.

1. From Bangley Creek, Cambewarra, N.S.W., of a clear reddish-brown colour, and in order to give precision to the tint, it is very like raw linseed oil, Strasburg turpentine, or dark balsam of Copaiba, but redder than any of them.

It has a specific gravity of 1·008 at 60°F., and an acidulous smell (owing to the presence of acetic acid), accompanied by an odour not so pleasant, and reminding one somewhat of spent tan liquors. It deposits a quantity of sediment of a buff colour, consisting almost entirely of catechin. It contains tannic acid ·772 per cent., "non-tannin" ·508 per cent. (Löwenthal's process.) The water amounts to no less than 98·3 per cent. The catechin was not estimated in this sample.

2. This was obtained from Cambewarra, but from a different locality. It is darker in colour than the preceding sample, being of a rich ruby colour. Like No. 1, it deposits a small quantity of sediment (catechin). This liquid kino had a specific gravity of 1·022 at 60°F., when received in April 1888.

The following results were obtained in December to January 1889:—Tannic acid 3·048 per cent. (of the liquid kino, without evaporating), "non-tannin" 1·27 per cent. (a portion of liquid kino, kept in agitation so as to obtain a fair proportion of sediment, was added to water to make up the strength of one grain of liquid kino to the litre); water 96·7 per cent. (after filtration from deposited catechin). The catechin and a little phlobaphene filtered off, were found to be in the proportion of ·495 per cent. of the original liquid kino. Ether agitated with the filtrate took up ·15 per cent., of which one-third was estimated to be catechin, and the rest resin.

Mr. Kirton has recorded liquid kino from the Illawarra district of New South Wales, but since there appears to be no reason why it should be found in one colony more than another, it will doubtless also be obtainable in Victoria, most likely on application to fishermen.

ART. XII.—*The Calculimetre.*

By JAMES J. FENTON, F.S.S.

[Read July 11, 1889.]

The Calculimetre is a circular measure of French make for performing approximate arithmetical and trigonometrical calculations. It consists of a flat disc of metal about the size of a watch, which can easily be attached to a chain and carried in a watch pocket. On one face, there are the two principal scales—one movable, the other fixed—for performing the ordinary rules of multiplication, division, and proportion; also a third scale for finding the squares and square roots of numbers. On the reverse face may be instantly found, by means of a movable arm, the logarithms of numbers, and the sines and tangents (the latter being under 45°) of angles.

This instrument is, of course, based on the principle of Gunter's line, *i.e.*, a scale divided logarithmetically, but marked with the natural numbers only, and has the advantage over the ordinary carpenter's and other similar slide-rules of convenience and portability, and a readier application to arithmetical calculations, besides having the additional scales for trigonometrical calculations. The arithmetical scales are about the same length as in the ordinary slide-rule, and, with good observation, results with the first three figures of a result can often be closely ascertained.

Some time ago, I brought before the notice of this Society, *Fuller's Calculating Slide-rule,** which will readily give accurate results to the fourth and sometimes to the fifth figure. In that ingenious instrument, however, the scale is of great length, being no less than 41½ feet, it being drawn in a spiral form round a cylinder; whilst in the more portable calculimetre the scale is only 6¼ inches in length, and of course cannot give the more extended results which may be obtained with the invaluable rule of Professor Fuller. But in cases where rough approximations

* *Vide* paper read 10th September, 1885. Two of these instruments have been in constant use in the office of the Government Statist for a long time past, and have proved most invaluable for statistical computations.

are required by architects, engineers, surveyors, analytical chemists, actuaries and statisticians, mechanics, mathematicians, students and others, the circular rule now exhibited will doubtless prove of valuable assistance.

A considerable amount of time and labour is constantly being wasted in the present day, by making long calculations out of all proportion to the accuracy of the data involved. Take surveyors' calculations for example. A good ordinary —say a 6-inch—theodolite is divided to twenty minutes of a degree (20′), in which case the lines would be only about $\frac{1}{60}$th of an inch apart. It is quite within the bounds of possibility, therefore, that a rough observation might be liable to an error of 10′, which would be equivalent to an error in the sine, varying (in the case of angles under 70°) from ·001 to ·003, according to the magnitude of the angle. The error would be thus in the third place, and what can be the use of employing tables of sines calculated to six or seven places when the observation is, in the case supposed, not correct to even three. By means of the vernier, in like manner the same instrument may, by careful observation, be read to say within one minute of a degree (1′); then the error in the sine of the angle would vary from ·0001 to ·0003, which involves an error in the fourth place, and so on, according to the accuracy of the observation, and the precision of the particular instrument used.

I think it may be laid down as a general rule in arithmetical operations that a computer is justified in accepting as correct only as many figures (digits) in the product or the quotient, as there are reliable figures in either of the factors, or in either the divisor or dividend, by which such product or quotient respectively was obtained. For example, supposing it was required to find a death-rate at a particular age, *i.e.*, deaths divided by population, assuming the deaths to be fairly correct, and the population to be uncertain beyond (say) the third figure, any death-rate based on such figures would be incorrect beyond the third figure. It is the same in the case of products, the number of reliable figures in the result being solely dependent on the number of reliable figures in the most uncertain of its factors.

In using logarithms, likewise, a similar general rule might be applied, *i.e.*, to use logarithms to as many places only* as

* In special cases one place more might be used, so as to ensure of the last figure but one being as accurate as possible.

correspond to the number of correct digits in the numerical data involved. For example, it would be useless labour to use the log. sines of angles observed with an error of one minute of a degree to six or seven figures of decimals, when a table of four figure logarithms would answer equally well.

When these things are well understood and appreciated, the more extended tables of logarithms will be used less and less, and slide-rules will come into more general use.

For results to the second and third figure, the small circular slide-rule is best adapted; and for results to the fourth figure, the spiral slide rule is most invaluable; but for results beyond the fourth, we must still resort to mathematical tables or the arithmometre.

The great advantage of slide-rules over logarithmic tables are obvious. To find a product by logarithms, no less than seven operations* are necessary, and then there is the liability to error as well as loss of time in transcribing the logarithms, after finding the differences, and in adding them. With the slide-rule, only the natural numbers are dealt with, and it is merely necessary to bring the indices to the factors and the results may read off immediately by inspection.

I should mention, that I described in my paper on Fuller's Calculating Slide Rule, a circular rule somewhat similar to the calculimetre, called the *Cercle à calcul.*† The cercle à calcul more nearly resembles a watch, the calculations being performed by two hands—the one movable, and the other fixed. The cercle à calcul is in some respects the better instrument, but it is about three times the cost of the other, which is only about ten or twelve francs.

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* Multiplying $a \times b$; (1) find a in log. book; (2) then log. a and transcribe; (3) find b; (4) then log. b and transcribe; (5) find sum; (6) find same in log. book; and (7) find colog. $a\ b$.

† A similar instrument made in England is known by the name of "Boucher's Pocket Calculator."

Art. XIII.—*On Finding the Longitude from Lunar Distances.*

By E. J. White, F.R.A.S.

[Read Thursday, October 10, 1889.]

About a fortnight ago the newspapers contained an account of the sufferings of the crew of the ship Garston, which had been wrecked, owing it is stated to a fault of the chronometer. On reading this, I was led to reflect on the methods at present in use for finding the position of a ship at sea. The latitude is obtained in so simple and so direct a manner that no notice will be taken of this operation, beyond remarking that the principal desideratum is a night instrument, to allow of altitudes of the stars being observed at other times than twilight, at which time only can the ordinary sextant be relied on for this purpose. The longitude problem is more complex, it resolves itself into two questions—finding the local time, and that of the first meridian, which to English speaking people, and indeed to most others now, is that of Greenwich. The observation for finding the local time is as simple as that for latitude, but the calculation is a little more complex, and it is dependent on the latitude, less so, however, when the body observed is east or west than in any other position. The finding of the Greenwich time is a more serious matter; it exercised the minds of men for many centuries, and large rewards were offered by the British Parliament to stimulate investigation. As far as navigation is concerned, the methods have been reduced to two—timekeepers, and moon observations, generally known as chronometers, and lunar distances. The chronometer method is so simple that it has now nearly superseded the other (I was informed by a naval officer a little time ago that he had never seen a lunar distance taken for finding the place of the ship, but only for the instruction of the naval cadets); but in my opinion, it is criminal to rely upon it for long voyages when less than three chronometers are carried, for such delicate machines are always capricious, and even the slight rusting

of the balance spring would render it quite untrustworthy. The observation and reduction of lunar distances has been a favourite pastime with me for forty years, and from the experience thus obtained, I have formed such a high estimate of the method, that I have viewed with sorrow its gradual disuse. Many reasons have been given for this state of affairs—one is, that seamen have not time for the necessary calculations, but with Thomson's tables, which are quite accurate enough for navigation, the time required for a reduction is only ten minutes. Another, and this I consider the true reason, is that the results could not be trusted. In the consideration of this it may be stated that about thirty years ago the lunar tables were so inaccurate that an error of twenty-two miles of longitude would sometimes be due to the Nautical Almanac alone. In 1862, Hansen's tables were first used in this work; these gave the place of the moon very accurately for some years, but commenced to diverge a little time ago, to counteract which, the Nautical Almanac applies Newcomb's empirical correction to the places of the moon used in computing the lunar distances, and the outstanding error is now very small indeed. Besides the errors of the Nautical Almanac, there are those of the sextant, which owing to excessive competition and lowering of price, are larger than formerly. It is quite surprising how rarely one meets with a really good sextant nowadays. Those made by the celebrated Troughton at the beginning of this century are still unsurpassed. I took the following excerpt from the catalogue of a manufacturer who exhibited at our last exhibition:—"We guarantee any of our best sextants to have a small margin of error (under 3′, and generally under 1′ of arc)." As the index error is easily and always ascertained by the observer, I suppose the error referred to is independent of this, principally excentric and division error, which is so troublesome to measure that it is generally neglected by seamen; and how would these errors affect a longitude determined from a lunar distance? by about thirty times their amounts—90′ and 70′ of arc respectively. I once had brought under my notice a modern sextant, where the excentric error amounted to 9′. If such a one had been used in a lunar distance, the error of longitude would have been about four degrees and a half. In other cases, sextants originally very good, have been ruined by incompetent repairers, or bungling treatment by their

owners. Those who wish to test the lunar method should practise at a place whose longitude is well known. The index error should be carefully found at each observation. The same dark glass or glasses should be always used for the sun, the grading of the brightness being obtained by the up and down motion of the telescope, and the contacts should be alternately made on and off. The errors of the resulting longitudes can then be tabulated or graphically described, whence a table of corrections for the different parts of the arc can be made. Some observatories contain special apparatus for testing sextants, but an ordinary observer would have more confidence in the former method. To those who wish to study the general theory of the sextant, I would recommend "Simms on the Sextant and its Applications," published by Troughton and Simms, of London, as the best work on the subject in our language. It is not, however, an easy book to read, and the notation is cumbrous and uninviting. For an example of finding the errors of a sextant from astronomical observations, the best work is the "Treatise on Practical Astronomy, as applied to Geology and Navigation," by Professor Doolittle, of the Lehigh University. The work was carried out by Professor Boss, the present director of the Dudley Observatory, and the various steps of the process are given with the minutest detail. The greatest correction found was 38 seconds of arc, which shows that the instrument was a very good one, for Simms states in the work before referred to, that there are few sextants in which the error which varies with the reading does not amount at its maximum to 40 seconds of arc. In many it exceeds 1 minute, and instances are to be met with where it amounts to 5 minutes.

For reducing a lunar observation, or clearing the distance as it is technically called, many methods have been devised, indeed, no other astronomical problem has shown such a fecundity of results, but their principles may be broadly divided into two—one the absolute solution of the two astronomical triangles presented by the problem, the other the differential variations of the parts of these triangles. The former of these is now seldom used, owing to the amount of work and care necessary; it is, however, the only safe one to use when the observed distance is very small. The shape in which this computation is carried out, is generally some slight modification of Borda's formula, published near the end of the last century. The large tables of Mendoza Rios

are also adapted to this method. At sea, the reductions are generally made on the differential principle, mostly by the aid of Thomson's tables, which give in a convenient shape, the result of an immense amount of labour, as the author stated that he solved more than 80,000 lunar distances in their construction; but for hydrographic and land observations, they are not sufficiently precise. In these cases, the rigid formula was, until lately, generally applied. About thirty years ago, however, Chauvenet, in his great work on Special and Practical Astronomy, gave a new investigation and tables for its application, by means of which the whole of the corrections can be taken into account, and the result obtained with nearly the accuracy of the laborious method of Bessel, who, as Chauvenet remarks, is the only one who has given a theoretically exact solution of the problem.

From the many hundreds of lunar observations I have taken in Australia, I select my observations of the last three years, as I wish to show the degree of dependence on them in the present state of the Nautical Almanac. They were all observed at my quarters, a little to the south-west of the Observatory. The instrument was a pillar sextant, Troughton No. 1139, it was made at the beginning of this century, and has been in my possession nearly forty years, during the whole of which time the index error, which is measured at each observation, has barely varied half a minute of arc, and the greatest excentric error is about twenty seconds. The objects observed, have been in every instance the sun and moon, which, from their slower relative motion, are theoretically less suitable than the moon and a star; but I find the results to be actually better, owing to the delicate contacts that can be made with two discs, and the advantage of daylight in noting the time and reading off the arc. Only one coloured glass has been used in all the observations, the equality of brightness of the two images having been obtained by altering the distance of the telescope from the plane of the instrument. No special selection of time has been made for observing, indeed from the fact that I keep my sextant at home, most of the observations have been made before 8 a.m. or after 5 p.m., when one of the objects is usually rather low, whereas on board ship the most favourable times could always be chosen. The barometer and thermometer have been read immediately after each observation for the proper correction of the refractions, and the reductions have been made by means of Chauvenet's

tables. The corrections for excentricity have not been applied; the results, therefore, are those given by a good sextant used in the ordinary way, with careful reduction. The local time has been taken from a chronometer watch, compared with the mean time clock of the Observatory. On a few occasions, it was taken from a clock beating seconds, whose error was determined in the same manner, and in only one instance is there a doubt about this element. The clock was used in the observation of October 14, 1888—it will be noted as the most discrepant but one of the series—it was reduced soon after it was observed and the discrepancy remarked, and on examining the clock, I found that in that part of the dial where the minutes were read, the zeros of the second and minute hands did not correspond, and I have reason to believe that a mistake of a minute was made in the local time; as I have, however, a great dislike to cooking observations, I have not changed the original entry of the observation. As the altitudes are in every case computed, a mistake in the mean time would affect them also.

Date.	Approximate observed Distance.	☾	Resulting Longitude.	Errors true obs.	Remarks.
1887. d. h.	° ′		h. m. s.	sec.	
Aug. 27, 5	107 52	E	9 40 49	— 55	Good.
Sept. 10, 21	85 55	W	39 43	+ 11	Cloudy.
Oct. 8, 19	105 3	W	39 24	+ 30	Very good.
Nov. 19, 23	62 43	E	40 29	— 35	Good.
Dec. 6, 19	105 40	W	40 8	— 14	Cloudy.
,, 8, 19	79 48	W	39 52	+ 2	Good.
,, 9, 19	66 28	W	40 9	— 15	Good.
,, 10, 19	53 5	W	39 48	+ 6	Good.
1888.					
Jan. 21, 7	91 22	E	39 23	+ 31	Cloudy.
,, 22, 3	101 19	E	39 58	— 4	Good.
,, 24, 6	124 17	E	40 19	— 25	Good.
Feb. 4, 20	88 9	W	39 45	+ 9	Good.
,, 15, 6	37 21	E	39 44	+ 10	Moon faint.
,, 17, 6	59 28	E	39 18	+ 36	Good.
,, 18, 4	69 59	E	38 58	— 4	Good.
,, 20, 6	92 29	E	39 55	— 1	Sun clouded.
,, 21, 6	103 34	E	40 28	— 34	Good.
June 2, 23	72 39	W	39 55	— 1	Cloudy.
Sept. 29, 20	71 52	W	39 12	+ 42	Good.
Oct. 14, 4	115 26	E	40 58	— 64	Good. Minute of local time doubtful.
Dec. 22, 19	130 5	W	39 16	+ 38	Good.
,, 24, 19	106 39	W	39 33	+ 21	Very good.
,, 27, 19	68 8	W	40 20	— 26	Good.

Date.	Approximate observed Distance.	☾	Resulting Longitude.	Errors true obs.	Remarks.
1889.					
Jan. 11, 6	115 15	E	40 45	— 51	Moon faint.
,, 21, 19	125 9	W	40 26	— 32	Very good.
,, 22, 19	112 28	W	39 55	— 1	Very good.
,, 25, 19	73 19	W	40 22	— 28	Cloudy. Moon faint.
,, 25, 22	72 19	W	40 16	— 22	Moon faint.
,, 26, 20	59 31	W	40 37	— 43	Good.
,, 27, 19	46 3	W	41 30	— 96	Cloudy. Very unsatisfactory.
Feb. 19, 21	129 38	W	39 49	+ 5	Hazy. Moon faint.
,, 20, 21	116 44	W	39 59	— 5	Good.
,, 22, 21	90 24	W	40 3	— 9	Very good.
Mar. 6, 5	51 50	E	38 46	+ 8	Moon faint.
,, 7, 6	63 6	E	39 40	+ 14	Sun clouded.
,, 10, 5	95 35	E	39 55	— 1	Very good.
,, 11, 5	106 43	E	40 32	— 38	Very good.
,, 12, 5	117 47	E	40 36	— 42	Good.
,, 13, 5	129 8	E	40 9	— 15	Good.
Aug. 3, 3	72 51	E	39 17	+ 37	Good.
,, 4, 1	84 28	E	39 58	— 4	Good.
Oct. 2, 5	92 49	E	39 17	+ 37	Very good.

The mean of the whole 42 observations is 9 h. 39 m. 59 s., which only exceeds the adopted longitude, as determined by telegraph, by 4·8 s. The mean of the 21 with the moon east is 9 h. 39 m. 59 s., of the remaining 21, with the moon west, is 9 h. 40 m. The probable error of a single observation is found from the residual errors to be ± 21 s., or a little more than 5 miles of longitude.

The result is, in my opinion, very satisfactory, for much larger errors than these have been found in the longitudes of places which have been determined with the large instruments of astronomical establishments. In one instance, that of the Lisbon Observatory, an error of nearly nine seconds of time was discovered a few years ago, when the longitude was measured by means of the electric telegraph. As observations can be taken at sea with nearly the same ease as on shore, except perhaps in the case of steamers, where the smoke and vibrations are very annoying, the results should be equally good, if the same care is taken in the reduction ; but where Thomson's and similar tables are used, the probable error would be rather larger.

In conclusion, I may express the hope that this paper may contribute towards rescuing this once favourite method of finding the longitude from the neglect into which it has

undeservedly fallen, and that it may lead to a stricter supervision of the instruments employed in nautical astronomy. I believe that all gun barrels have to be submitted to a Government test, but if one burst, little harm would be done, except to the user. In the case of sextants and chronometers no supervision is exercised in their manufacture, and the selection is left to individual caprice, yet a faulty one may cause the loss of much property and many lives.

ART. XIV.—*On the Pseudogastrula Stage in the Development of Calcareous Sponges.*

By ARTHUR DENDY, M. Sc., F.L.S.

Fellow of Queen's College, University of Melbourne.

(With Plate 1A.)

[Read November 14, 1889.]

Thanks to the researches principally of Metschnikoff, Schulze and Barrois, we are now in possession of a tolerably full and accurate account of the development of the Sycon type of calcareous sponges, as represented by the genus *Sycandra*. It is in the hope of contributing a small addition to our knowledge in this department of embryology that the present paper is written.

Before going on to describe my own observations, it will be advisable to give a brief account of the now generally accepted views concerning the history of the development of *Sycandra*—such, for example, as is to be found in Balfour's "Treatise on Comparative Embryology."

The ovum is a naked, amœboid, nucleated mass of protoplasm, which, after fertilization, undergoes the early stages of its development within the tissues of the mother sponge. The ovum first divides vertically into two and then into four segments. The next two divisions are also

The sponge which formed the subject of my own investigations, is the remarkable form originally named by Carter *Teichonella labyrinthica.* I propose shortly to publish a full account in another place of the anatomy of this sponge; meanwhile it is necessary to state that it does not belong to the genus *Teichonella* at all, but is a true Sycon—a fact, indeed, which Mr. Carter himself recognises in one of his later papers,* wherein he suggests that its generic name might be changed from *Teichonella* to *Grantia.* The sponge consists of a stalked cup, with a thin and very much folded wall. The flagellated chambers penetrate the walls of the cup in a direction at right angles to the two surfaces and open on the inner surface into the widely expanded cavity, corresponding to the gastral cavity of a typical Sycon; the osculum being enormously large and bounded by the folded margin of the cup.

I do not wish here to discuss the generic nomenclature of this sponge, which question I reserve for consideration in my forthcoming paper; but as it certainly cannot be called *Teichonella,* the type species of which I find to be a typical Leucon, I will, provisionally at any rate, adopt Mr. Carter's suggestion and call it *Grantia labyrinthica.*

In a fine specimen of *Grantia labyrinthica,* dredged by Mr. J. Bracebridge Wilson at Easter 1888, whilst I was myself with him, I met with a very large number of embryos. These were found both in the maternal tissues and also lying free in the flagellated chambers. While still within the maternal tissues the embryo lies in a cavity, which is but little larger than itself and lined by a very distinct single layer of flattened endothelial cells (*vide* Fig. 1). This capsule always lies in the thin layer of mesoderm between the wall of a flagellated chamber and the layer of spicules which surrounds it. Hence the capsule is bounded on the outside by the soft and yielding wall of the flagellated chamber, and on the inside by a layer of rigid spicules. As the embryo increases in size the capsule in which it lies becomes correspondingly enlarged, and owing to the manner in which it is bounded this enlargement must take place towards the flagellated chamber. Thus the side of the capsule next to the layer of spicules becomes flattened, while the opposite side bulges out into the flagellated chamber and forms a kind of blister, over which the delicate wall

* "Annals and Magazine of Natural History," July 1886, p. 38.

of the chamber becomes tightly stretched. These relations are of great importance in considering the development of the embryo, and they appear to be perfectly constant. Judging from the figures of Schulze, Barrois, and Metschnikoff, the embryo of *Sycandra* appears to be very similarly situated.

The youngest embryos in *Grantia labyrinthica* are always found near the margin of the sponge-cup, not far from the last formed flagellated chamber. Figure 1 represents the earliest stage found. The embryo here represented may be considered as in a late blastosphere stage, closely resembling the similar stage in *Sycandra raphanus*. The layer of elongated columnar cells is strongly arched, so as to form almost a hemisphere and lift up the wall of the flagellated chamber in the form of a blister as above described (owing to the direction in which the section happened to be taken this is not very well shown in the figure). The ovoid granular cells still form a single layer, or very nearly so, but show signs of proliferation already. This layer is flattened, and it is easy to see from the figure that the flattening is caused by the presence of the layer of rigid spicules beneath them. In this and in all the numerous other embryos which I have examined in the maternal tissues the ovoid granular cells are turned towards the layer of spicules, and the columnar cells towards the flagellated chamber. According to Schulze,* prior to this stage in *Sycandra raphanus* the layer of granular cells is always turned towards the flagellated chamber, but after this stage he finds the embryo in very different positions in the capsule, "gewöhnlich sogar mit dem hellen convexen Zellenlager dem Radialtubus zugewandt," Judging from this change in position, Schulze considers that from now onwards the columnar cells are ciliated. In my sections, made from spirit material, I have naturally enough not observed any cilia.

Even in this early stage of development the segmentation cavity is no longer quite empty, but contains a quantity of very delicate, finely granular, gelatinous-looking tissue (Fig. 1 *mes.*), in which a number of small, deeply staining nuclei are very distinctly visible. This tissue appears to be of constant occurrence, and is probably the commencement of the mesoblast, or mesoderm of the adult. It is quite uncertain from which layer it is derived, but the similarity of the nuclei to those of the columnar cells, and the fact that

* "Zeitschrift für wissensch. Zoologie," Vol. xxv. (Supplement), pp. 271, 272.

some of the latter nuclei—as shown in Figures 1, 2 and 4—are found out of the row, and apparently approaching the segmentation cavity, seems to indicate that it may possibly be derived from the layer of columnar cells. On the other hand, the granular cells, as I have already said, are already showing signs of proliferation, and may possibly have given rise to the tissue in question.

As development goes on the granular cells proliferate rapidly, especially towards the middle of the layer, where they become smaller and more numerous than at the periphery. As they go on increasing they occupy more and more space, and hence, as they cannot project outwards, on account of the rigid layer of spicules beneath them, they become invaginated, and give rise to the *Pseudogastrula* (Figs. 2, 4). The Pseudogastrula, then, is due to a mechanical invagination of the layer of granular cells, caused by their active growth and the peculiar situation of the embryo. These cells do not now, however, form a single layer, as is usually supposed, but a layer several or many cells thick. Such is certainly the case in *Grantia labyrinthica*, and, judging from the observations of Metschnikoff, to which I shall refer more in detail later on, I think it will probably be found to be the case also in *Sycandra raphanus*. The advantage of thin serial sections in the determination of such a point is obvious, and probably this method of investigation will lead to similar results in the case of the latter species.

At about this period of its life history the embryo leaves the maternal tissues, and escapes into a flagellated chamber, by rupture of the outer wall of the capsule (Fig. 3). This rupture of the capsule takes place in a ring, around the base of the blister which the embryo causes on the wall of the flagellated chamber. It involves, of course, not only the wall of the capsule, but also the wall of the flagellated chamber, which by this time has become tightly stretched and the collared cells composing it apparently flattened out. The outer part of the endothelial lining of the capsule and the portion of the wall of the flagellated chamber immediately overlying it appear to come away with the embryo when the latter breaks loose, forming a more or less structureless membrane, closely adherent to the layer of columnar cells (Fig. 4 *s.m.*) After the escape of the embryo the remains of the capsule appear on the wall of the flagellated chamber as a shallow recess lined by flattened endothelial cells (Fig. 3 *e.c.*)

By this time the granular cells have increased so much in bulk, and became so far invaginated as to reduce the segmentation cavity to a mere slit, in which, however, the primitive mesoblastic tissue is still recognisable (Fig. 4.)

The next distinct stage is represented in Fig. 5. The embryo is now solid and almost spherical. The columnar cells have elongated and their inner ends reach nearly to the centre of the embryo. The segmentation cavity is perhaps represented by a dark area in the centre. The granular cells form a hemispherical mass, which is the posterior half of the embryo. This mass has become differentiated into two distinct parts—(1) an external single layer of clearer, more or less cubical, nucleated cells; and (2) an internal mass of highly granular, larger, nucleated cells, which are ovoid or more or less polygonal from mutual pressure.

In the latest stage which I have seen (still within a flagellated chamber), the embryo has become somewhat pointed at the anterior extremity, and the boundaries between the internal granular cells are no longer distinctly visible. Fig. 6 is a diagram of this stage, representing the free swimming embryo as it leaves the parent sponge on its way to seek a place of fixation. As already stated, I have not myself seen the cilia, but there cannot be the slightest doubt, after the observations of so many authors on the living organism, of their existence.

Certain observations of Metschnikoff on *Sycandra* form a strong confirmation of my views as to the development of the Sycon type of calcisponge. This author* states that in the older larvæ, the posterior part, devoid of cilia, does not remain so simple as in the earlier stages. A cavity is developed in it which divides it into two layers. Sometimes also he found and figures (*loc. cit.* Fig. 11) a larva which closely agrees with that represented in my Fig. 5, in which the posterior half consists of an outer layer of epithelial cells and an inner mass of rounded cells closely packed. This internal mass he derives from the inner of the two layers into which the granular cells are first of all divided. Exactly how the original division of the granular cells took place is not made clear. Metschnikoff appears to have observed the fact that there is a division only after the pseudogastrula stage has been passed through. I suspect that the true course of events is very much the same as I have described

* "Zeitschrift für wissensch. Zoologie," Vol. 32, p. 368 *et seq.*

for *Grantia labyrinthica.* Concerning the inner mass of granular cells, Metschnikoff continues, "Diesen Zellenhaufen kann man als Mesoderm deuten, wie es solche Larven beweisen, wo in demselben sich mehrere Nadeln vorfinden (Fig. 13). Ich will nicht behaupten, dass die von mir beschriebenen Stadien durchaus normale sind; ich glaube vielmehr, dass sie uns eine sehr verfrühte Bildung des Mesoderms, resp. der Nadeln repräsentiren, welcher Vorgang aber mit dem normalen qualitativ ganz ähnlich verläuft. Wenigstens habe ich auch an vollkommen regelmässig und normal ausgebildeten Stadien eine, wenn auch bei weitem nicht so stark ausgebildete Mesodermanlage wahrgenommen."

Metschnikoff, then, has certainly seen in *Sycandra* something closely resembling what I have found in *Grantia labyrinthica,* and it is highly probable that the development of the two forms is almost, if not quite, identical. Metschnikoff's interpretation of the appearance of the internal mass of granular cells as an unusually or abnormally early development of the mesoderm is probably due to the fact that in older larvæ he finds this mass to be no longer visible. This fact, however, is easily explained according to my view of the case, which is as follows:—

The embryo already at a very early stage lies within a cavity lined by a special layer of endothelial cells. As it develops it increases greatly in size, and obviously receives nutriment from the mother sponge, probably through the medium of the endothelial cells.* Balfour† has already expressed the opinion that the granular cells of the free swimming embryo are nutritive in function, and this I hold to be correct, though I do not suppose that they take in any food while the embryo is swimming about. I maintain that the granular cells absorb nutriment from the maternal tissues, increase in size, proliferate rapidly, become mechanically invaginated as before explained, and when they have done absorbing nutriment become arranged in a hemispherical mass of large ovoid cells, highly charged with food granules, and an investing epithelial layer (Fig. 5). The embryo is now ready to lead an independent existence, and the internal mass of granular cells is, I believe, a supply of food which enables it to wander for a long distance before becoming

* Compare my account of the embryos of Stelospongos flabelliformis.—*Quart. Jour. Micro. Sci.*, December 1888.

† "Morphology and Systematic Position of the Spongida."—*Quart. Jour. Micro. Sci.*, vol. xix., 1879; also, "Comparative Embryology," vol. i., p. 122.

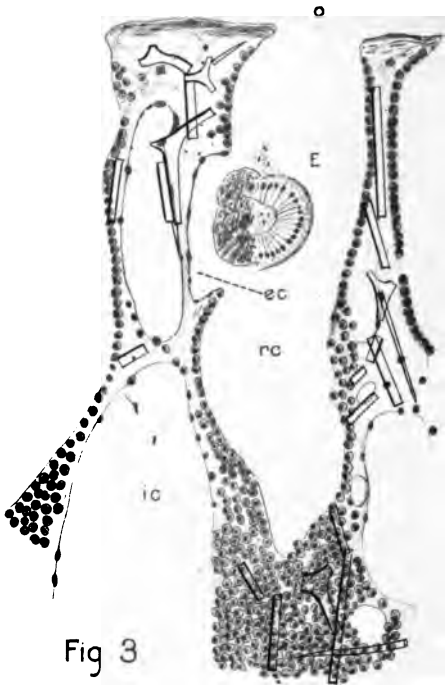


Fig 3

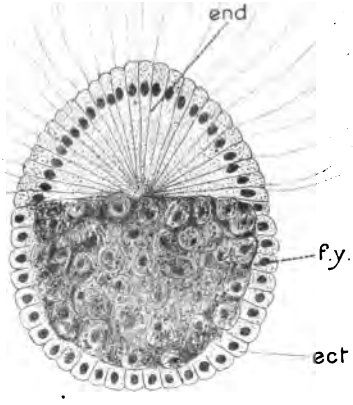


Fig. 6.

Troedel & Cº Lith.

fixed. By degrees this food is absorbed and used up, then the invagination of the ciliated cells takes place, and the embryo becomes attached. Hence, in the gastrula stage, the internal granular mass of cells is no longer visible.

Thus I think that the internal granular mass of cells is to be looked upon as food-yolk, and that it has little or nothing to do with the formation of the mesoderm. The latter, as I have already shown, appears to be present before the mass of food-yolk is formed, and though hidden by it later on (Figs. 5 and 6), is doubtless still there, and from this tissue the spicules observed by Metschnikoff probably arose.

My investigations were carried on by means of serial sections of the mother sponge, stained with borax carmine and embedded in paraffin.

EXPLANATION OF PLATE 1A.

The following explanation of the lettering applies to all the figures:—

col.—Collared cells lining the flagellated chambers of the mother sponge.
e.—Embryo.
e.c.—Capsule containing the embryo and lined by flattened endothelial cells.
ect.—Ectoderm.
end.—Columnar cells of the embryo, which will form the endoderm of the adult.
f.y.—Mass of granular food-yolk-containing cells derived from the invagination and proliferation of the granular cells of younger stages.
gr.—Granular cells of embryo.
i.c.—Inhalant canal of mother sponge.
mes.—Commencement of mesoderm of embryo.
o.—Opening of a flagellated chamber into the gastral cavity of the mother sponge.
r.c.—Flagellated chamber of the mother sponge.
s.m.—Structureless membrane, formed of the outer part of the embryo capsule and the remains of the collared cells lining the flagellated chamber of the mother sponge.
sp.—Spicule of the mother sponge.

FIGURE 1.—Section of embryo in late blastosphere stage, lying within the embryo capsule in the maternal tissues, between a layer of spicules and a flagellated chamber.

FIGURE 2.—Section of embryo at the commencement of the pseudogastrula stage, represented apart from the maternal tissues by which it is surrounded.

FIGURE 3.—Portion of section of the mother sponge, showing an embryo breaking loose from the embryo-containing cavity into a flagellated chamber. (The spicules are represented in blue).

FIGURE 4.—Section of embryo in late pseudogastrula stage, with the structureless membrane which adheres to it on its escape from the maternal tissues.

FIGURE 5.—Section of a solid embryo found in a flagellated chamber of the mother sponge.

FIGURE 6.—Section of the free-swimming, ciliated embryo (diagrammatic).

ART. XV.—*The Pineal Eye of Mordacia mordax.*

With Woodcut.

By PROFESSOR W. BALDWIN SPENCER, M.A.

[Read June 13, 1889.]

In 1883,* Ahlborn published an account of the structure of the Pineal gland in the lamprey Petromyzon; the discovery and investigation of the structure of the Pineal eye in Lacertilia some three years later, led Beard† to investigate the nature of the Pineal gland in Cyclostomata, and his full results published in 1888 showed that, as in lizards, the distal part of the gland was, in certain Cyclostomata, transformed into an eye-like structure, though one not so highly developed as in the former group.

His work was done upon *Petromyzon* and the larval form *Ammocoetes*, and upon *Myxine*. In these three he found, though not constantly, that pigment was deposited around the cells forming the vesicle of the epiphysis.

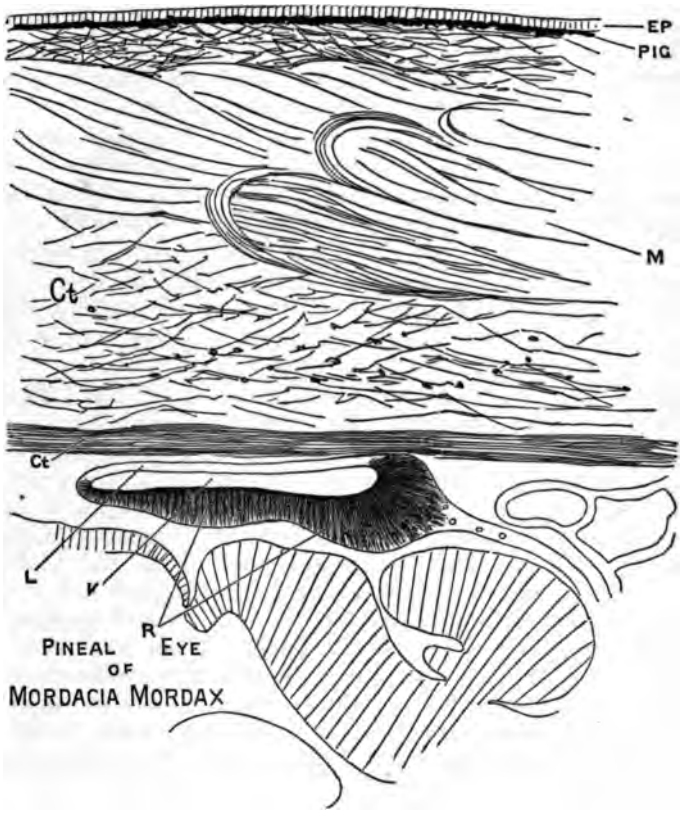
He was unable to secure a specimen of the Australian form *Mordacia*, and I am indebted to the kindness of Professor McCoy for placing at my disposal a specimen of the latter genus, upon an investigation of which this note is based. The specimen was obtained in Victoria, and Professor McCoy tells me that he has identified this with the Tasmanian form.

Ahlborn had already described in detail the relationship of the epiphysis to the brain and its union with the left ganglion habenulæ, and the division of its distal or vesicular portion into two parts—an upper larger, and a lower smaller vesicle. It was, in fact, simply Ahlborn's misfortune in not meeting with a specimen in which dark pigment was developed which prevented him from first discovering, by

* "Untersuchungen über das Gehirn von Petromyzonten."—*Zeitschr. für Wiss. Zool.*, Bd. xxxix., Heft. 2, 1883.

† "The Parietal Eye of the Cyclostome Fishes."—*Q.J.M.S.*, 1888; also *Nature*, July 14, 1887.

actual investigation, the true nature of the epiphysis, though both he and Rabl Rückhard had independently arrived at the conclusion that the Pineal eye was to be regarded as the rudiment of an unpaired eye.



DESCRIPTION OF WOOD CUT.

MEDIAN LONGITUDINAL VERTICAL SECTION THROUGH A PART OF THE HEAD OF MORDACIA MORDAX IN THE REGION OF THE PINEAL EYE.

Ct.—Connective tissue.
Ep.—Epidermis.
L.—Lens part of the eye.
M.—Muscles.
Pig.—Pigment immediately beneath epidermis.
R.—Retina.
V.—Ve iclo o eye filled with fiuid during life.

The brain of the specimen examined by myself was not, unfortunately, in a good state of preservation, not having been intended especially for histological work. Externally there was when preserved in spirit no indication of the presence of a Pineal eye. In a specimen of Petromyzon which has lain for some time in turpentine so as to render the tissues somewhat transparent, there is a strongly marked white spot indicating the epiphysis lying beneath, but in Mordacia no such indication was visible.

Longitudinal vertical sections, however, revealed the fact that the larger vesicle is attached by a stalk to the dorsal surface of the brain, and that in its walls an abundant deposit of pigment of a dark brown colour is developed.

The vesicle is of large size, and is flattened out against the roof of the brain case, and it may perhaps be due to the state of preservation of the brain in the particular specimen examined, but I could find no trace of the lower of the two vesicles normally present in Cyclostomata.

The eye stretches forward much compressed dorso-ventrally, and overlaps the cerebral hemispheres, its posterior end being continuous with the optic stalk, and being somewhat swollen out. Its walls are composed of long rod-like cells embedded in brown pigment, and facing into the cavity of the vesicle. These cells are longest at the posterior end, where the stalk joins the vesicle, resembling thus the eye in many Lacertilia, and the whole structure is very similar to that figured by Beard as present in *Petromyzon.** The rod-cells appear to be in connection at their outer ends with nuclei, though these could not be detected with absolute certainty, owing to the incomplete histological state of the brain. My experience of other Pineal eyes makes me have little doubt, however, that they are present.

Of a true lens, that is of a cellular structure which could serve to focus rays of light entering the eye, it must be confessed, that neither here nor in the specimens figured by Beard, can one be said to be present. The vesicle wall is complete, and anteriorly consists simply of a comparatively thin layer, in which no pigment is deposited, and through which rays could easily pass to impinge upon the retina beneath. The layer appears to be of equal thickness all the way across, and there is no median swelling out, such as is

* Op. cit. Pl. VI., Fig. 1.

so constantly seen in the Lacertilia, nor in the specimen examined could the outlines of cells be in any way distinguished owing, again, doubtless, to the bad state of preservation.

The cavity of the vesicle, as in Ahlborn's and Beard's specimens, is apparently filled with fluid which coagulates when preserved in spirit.

In two points, with regard to the eye, *Mordacia* differs from *Petromyzon* as described by Beard:—

First, although the pigment is very well developed the eye is not placed in a deep depression of the skull, the latter passing quite evenly above the epiphysis. Beard points out the curious fact that in *Petromyzon*, when the pigment is well developed, the depression is deep; when absent, the depression is almost or entirely absent.

Secondly, the pigment in the skin (pig.) passes straight over the eye which would render it difficult and, when added to the layer of muscle and skeleton above the epiphysis, practically impossible for rays of light to reach the structure. In *Petromyzon*, Beard states that the pigment in the skin is absent above the eye.

There can be little doubt that here, as I believe, in all other animals in which it is now found, the Pineal eye must, as an organ for the perception of rays of light, be regarded as rudimentary and functionless.

ART. XVI.—*Description of New or Little Known Polyzoa.*

PART XIII.

By P. H. MACGILLIVRAY, M.A., M.R.C.S., F.L.S.

(With Plates IV and V.)

[Read November 14, 1889.]

NOTAMIA GRACILIS, McG.

Zoœcia very long and slender, aperture occupying almost the whole of the anterior surface, rounded or quadrate above, and with the superior margin projecting slightly forwards; a pedunculate, capitate avicularium on one or both sides, from the upper part of the posterior tube.

In a paper read before the Society in November 1885, I briefly described a species as *Calwellia gracilis*, from one or two very imperfect fragments, believing it to be a species indicated, but not described, by Mr. Maplestone. This identification is, however, somewhat doubtful, as I have on several occasions had specimens sent to me named *C. gracilis*, which proved to be merely rather slender forms of the well known *C. bicornis*. After my brief and necessarily imperfect description was published, I received from Mr. Whitelegge some fragments on an alga from Port Jackson, as well as specimens mounted in balsam. These have enabled me to make out its real structure, and to confirm Mr. Whitelegge's opinion, that it belongs to the genus Notamia.

Notamia gracilis is at once distinguished from the only other species, the European *N. bursaria*, by its much smaller size, the slenderness of the zoœcia, the rounded or somewhat quadrate form of the upper part of the aperture and its projection forwards, and the more slender attachment of the avicularia to the posterior tube, which also is not enlarged to the same extent above.

STIRPARIA EXILIS, n. sp., Pl. IV.

Zoarium very small, flabellate, branches dichotomously divided. Zoœcia alternate, elongated, upper edge straight,

with the outer angle turned forwards; aperture large; a single, long, hollow, articulated spine from the outer angle, and one or two from immediately behind the upper edge. The first cell of the zoarium with a large number (six or seven) of spines, and the succeeding two with three or four. No avicularia.

A very small species, about an eight of an inch high, growing on sponge. The stem consists of a few lengthened internodes, with intervening round ball-like joints.

The appropriate name was suggested by Mr. Wilson.

Port Phillip Heads, Mr. J. Bracebridge Wilson; Port Jackson (a young specimen), Mr. Whitelegge.

BIFLUSTRA SERICEA, n. sp., Pl. V, Fig. 1.

Zoarium encrusting. Zoœcia oval or elliptical, with raised finely crenulated borders, within which the aperture is entirely membranous. A single sessile avicularium, with a broad triangular mandible, situated on a space above each zoœcium or oœcium. Oœcia rounded, with a small, inversely clavate ridge.

Allied to *B. Lacroixii* and *Membranipora cyclops*, Busk, but I believe distinct from both.

Port Phillip Heads, a single specimen.

BIFLUSTRA UNCINATA, n. sp., Pl. V, Fig. 2.

Zoarium adnate, hemescharine or bilaminate. Zoœcia large, arranged alternately in linear series, separated by raised margins, aperture elliptical, partly filled in, especially below, by a narrow smooth extension of the raised margins, the edge being smooth or very faintly denticulate; on each side above is a short, stout, pointed, and somewhat uncinate process, from the thickened margin.

Allied to *B. delicatula* and *perfragilis*, from which it is distinguished by the stout uncinate processes.

Port Phillip Heads, Mr. J. Bracebridge Wilson.

SCHIZOPORELLA IMPAR, n. sp., Pl. V, Fig. 3.

Zoœcia elongated, irregularly arranged, separated by distinct raised lines, surface covered with small hollow granulations; mouth semicircular, or slightly contracted below; lower lip straight, with a distinct, rather wide, sinus; peristome above becoming thickened, projecting, and

bevelled internally. A transverse avicularium, with large rounded mandible, usually on a considerable mound-like elevation, immediately below and to one side of the mouth.

Western Port, Rev. Mr. Porter.

SCHIZOPORELLA SPECIOSA, n. sp., Pl. V, Fig. 4.

Zoarium encrusting. Zoœcia very irregular in shape and arrangement, indistinctly separated by very narrow raised lines; surface rough, with hollow granulations; mouth arched above, higher than broad, a distinct, widely open, shallow sinus in the lower lip. A transverse elliptical avicularium to one side of the oral sinus. Scattered large vicarious avicularia, with very large thin mandibles. Oœcia reniform, with thickened rim, and several white-bordered pores, or granulations, on the convex surface.

With age, the zoœcia become highly calcified, the oral apertures, however, remaining on the surface; the peristome at the sides is much thickened and produced; the rim of the oœcia is thickened, and the pores very marked; the surface of the zoœcia, also, has numerous pores, or areolations. The edges of the vicarious avicularia are thickened and calcareous, the mandibles remaining thin and membranous.

Allied to *Schizoporella Maplestonei*, a variety of which has been described by Mr. Hincks from Western Australia as *S. lucida*, from which it differs in the suboral sinus being wide and open above, as well as in the peculiar vicarious avicularia.

Port Phillip Heads, Mr. J. Bracebridge Wilson; Western Port, Rev. Mr. Porter.

SCHIZOPORELLA NODULIFERA, n. sp., Pl. V, Fig. 5.

Zoœcia somewhat quadrate, separated by narrow raised lines; surface (young) granular and perforated, when more fully developed with large shining calcareous nodosities; oral aperture large, nearly quadrate above; lower lip straight, with a wide rather deep sinus. A broadly elliptical avicularium, with large mandible, usually situated transversely below the mouth, on one side. Oœcia subimmersed, with a thickened border, flattened in front, and usually with several large white-bordered pores.

In this very striking species, the young zoœcia have the surface granular and nodular, with perforations between the nodules; the oral aperture is very large, with a wide sinus

in the lower lip. In older zoœcia, the peristome becomes raised, and very large porcellanous nodules become developed. Between the zoœcial nodules are numerous large pores. The oœcia are immersed, flattened in front, with two or three large white-bordered pores; the border thickened, and with several large nodules. The suboral avicularium, which is present in the large majority of zoœcia, is also a marked feature. The space below the mouth, containing the avicularium, is usually destitute of nodules. The size and prominence of the nodules make the oval aperture seem very deep, and give the specimen a very peculiar appearance.

Western Port, Rev. Mr. Porter.

SCHIZOPORELLA PORTERI, n. sp., Pl. V, Fig. 6.

Zoœcia confused, indistinct; surface smooth and polished; oral aperture rounded above, with a well defined wide sinus in the straight lower lip. Below the sinus, a small avicularium with vertical rounded mandible, on the upper edge of an elevation of the cell. Numerous scattered avicularia between the zoœcia, with triangular mandibles, on mound-like elevations. Oœcia subimmersed, a nearly circular portion in front remaining membranous.

The scattered avicularia, and confused arrangement and size of the zoœcia, give a superficial resemblance to some specimems of *Rhynchopora bispinosa*, from which, however, the structure of the mouth is quite different. The incomplete calcification of the oœcia is very peculiar, and seems to be constant.

Western Port, Rev. Mr. Porter.

MUCRONELLA MENTALIS, n. sp., Pl. V, Fig. 7.

Zoœcia elongated, alternate, in regular lines, separated by deep grooves; a row of deep rounded areolations or pores along the margins; surface granular; mouth arched above, lower lip projecting as a rounded process, bulging below the mouth; six articulated spines on the upper margin. Oœcia rounded, granular, subimmersed in the cell above.

Port Phillip Heads.

LAGENIPORA SIMPLEX, n. sp., Pl. V, Fig. 8.

Zoœcia much enlarged below, contracted at the mouth, with the produced peristome either circular at the orifice

or bilabiate; surface smooth, glossy, with a few minute shining granulations.

Differs from *L. tuberculata* in the absence of pores or tubercles.

Western Port, a single specimen, Rev. Mr. Porter.

AMATHIA PLUMOSA, n. sp.

Zoarium large, tufted. Primary branches cylindrical, without zoœcia. Secondary branches given off oppositely in pairs, each secondary branch bifurcating, the branch before bifurcation occupied, except at the basal portion, with a cluster of about six pairs of cylindrical zoœcia, and each bifurcation having a similar or smaller group, each of these bifurcations terminating on a pair of confervoid filaments, which again divide at their extremities.

Port Phillip Heads, Mr. J. Bracebridge Wilson.

EXPLANATION OF FIGURES.

PLATE IV.

Fig. 1.—*Stirparia exilis*, natural size.
Fig. 1a.—Portion magnified.
Fig. 1b.—Stem and lower zoœcia of the same.

PLATE V.

Fig. 1.—Biflustra sericea.
Fig. 2.—Biflustra uncinata.
Fig. 3.—Schizoporella impar.
Fig. 4.—Schizoporella speciosa.
Fig. 4a.—Young zoœcium.
Fig. 5.—Schizoporella nodulifera.
Fig. 5a.—Mouth of zoœcia.
Fig. 6.—Schizoporella porteri.
Fig. 6a.—Young zoœcium.
Fig. 7.—Mucronella mentalis.
Fig. 8.—Lagenipora simplex.

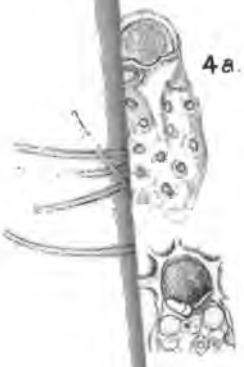
ART. XVII.—*On the Illumination of Public Clocks.*

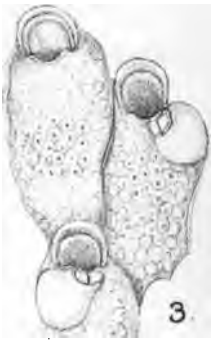
By SIDNEY W. GIBBONS, F.C.S.

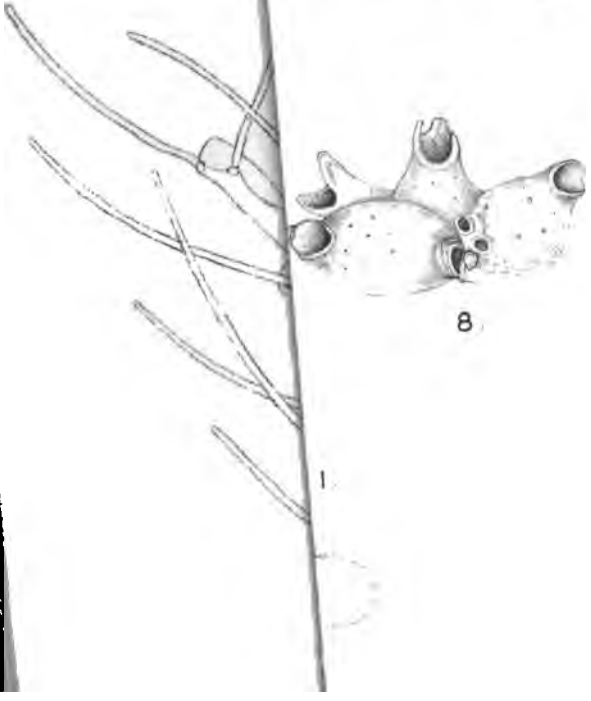
[Read December 12, 1889.]

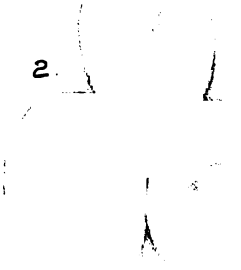
Proc. R.

Plate 5.









Art. XVIII.—*Notes from the Biological Laboratory of the Melbourne University.*

(With Plate VI.)

[Read December 12, 1889.]

(1) *On the Occurrence of a Partially Double Chick Embryo.*

By A. H. S. Lucas, M.A., B.Sc.

Formerly, abnormal growths of plants and animals excited interest as being curious marvels, monstrosities, so-called *lusus naturæ*. Now-a-days, they are studied in the hope of discovering in them extraordinary, and perhaps therefore especially instructive, manifestations of ordinary laws of growth.

The younger such abnormal forms are, the more light are they likely to throw upon the difficult problems, latterly so much discussed, concerning the physical causes of heredity and variation.

The chick will probably, owing to the ease with which material for research can be procured and manipulated, always furnish the standard type of development amongst the higher vertebrates. It seems well then to record occurrences of healthy chick embryos which depart in a marked manner from the ordinary lines of growth, especially as such embryos appear to be somewhat rarely met with.

The particular embryo under consideration had been incubated about twenty-seven hours, and presents most of the features characteristic of this time. The blood-vessels are definitely forming in the vascular area. The vitelline folds are clearly indicated. The central nervous system, and the mesoblastic somites, have their usual appearance at this stage.

The embryo is, however, partially double. In front, it forks to form two very distinct heads, of which one is larger

than the other. Both are fully developed up to date; the unsegmented brain being carried over the front of the head fold producing the mitriform appearance. The (optical) right neural fold of the right head is continued back along the common trunk, and so the left neural fold of the left head. The adjacent neural folds can only be traced to the level of the point of divergence of the fork, and seem to meet as they thin out. They are quite wanting in the trunk.

There are eight rows of mesoblastic somites with definite outlines, and traces of others can be discerned. The outer row on each side is normal, and close to the corresponding neural fold. The two inner rows have fused to form compound median somites, which have double the width of the single outer ones. The hinder part of the primitive streak is double, the two divisions running outwards at right angles to the main axis of the embryo. The vascular area and the primitive heart seem to be quite simple. The specimen was mounted as a whole, and I am unable to distinguish the hypoblastic structures.

The double form may have been produced in two ways. The product of a single germinal vesicle may have undergone a certain amount of longitudinal dehiscence, or the products of two germinal vesicles may have partially fused in the growth side by side, on a yolk originally common to both, or formed by union of the two yolks. The process, whichever it has been, has affected all the three germinal layers at the two extremities, where the separation of the two embryos is complete. In the region of the somites, the somatopleure is distinctly divided into two equal longitudinal halves, which have remained in juxtaposition; the splanchnopleure does not show any signs of fission.

I do not think that there is any evidence upon which we can decide in which of the two ways the doubling has been brought about, but it is plain that the cause must have been deep-seated, and must be looked for in far earlier stages.

(2) *On the Formation of a Double Embryo in the Hen's-egg.*

By Professor W. Baldwin Spencer, M.A.

Whilst working in the Biological Laboratory of the Melbourne University, one, amongst a large number of hens' eggs incubated, was found to present the curious feature of having two clearly-formed embryos developed within the limits of the one blastoderm. As this is by no means of common occurrence, and as the embryos were quite distinct, and developed to a considerable extent, it has been thought worth while to figure them (Pl. VI, fig. 2). Wolff, Reichert, Thompson, and others have previously shown that this may take place, and a figure showing two chick embryos distinct from one another, is given by the latter investigator.* In this case two embryos, of a very early stage, each showing what is probably meant for the primitive groove, are seen lying side by side, with their anterior ends close together. They are not sufficiently developed to show traces as yet of mesoblastic somites or nervous system. The anterior ends of the two are closely approximated, whilst the posterior ends diverge from one another. In the embryos figured by myself, the blastodermic area is somewhat elongated in the direction corresponding to that of the short axis of the egg; the area pellucida and the area opaca are clearly distinguishable from each other and the latter is covered with a complete network of blood-vessels, limited externally by the sinus terminalis. The two embryos are so placed that their anterior ends lie side by side in the middle of the area pellucida, whilst their posterior ends are directed towards the two opposite ends of the area. The two embryos are precisely similar to one another. Each has reached the stage at which the nervous system has the form of a tube, the anterior end of which is becoming swollen out to form the vesicles of the brain, though these are not as yet clearly differentiated. At the posterior end of the body the neural canal is still widely open, and encloses the remnant of the primitive streak and groove. The head-fold has lifted the

* I am indebted to Professor Allen, M.D., of the Melbourne University, for the opportunity of seeing this. It is to be found in "Todd's Cyclopædia of Anatomy and Physiology," under the article "Teratology."

head up above the blastoderm, but the latter is not yet enclosed by the amnion. In the middle region of the body seven pairs of mesoblastic somites are present.*

The vessels passing across the area pellucida to the embryos are not yet clearly visible, and the sinus terminalis is perfectly complete, no such structures as the one or two large vessels being present, which in the normal embryo return the blood to the body from the sinus at the anterior end.

Apparently, every stage may be met with between an embryo which shows reduplication of one portion of the body and the condition in which, as described above, two perfect embryos are formed within the area of the same blastoderm. One of these stages is represented in the adjoining drawing (Fig. 1), by Mr. Lucas, of an abnormal embryo, showing a clearly double formation at the head end and an indication also of doubleness at the posterior extremity, where the primitive streak divides into two halves, running out right and left of the median line. Occasionally an embryo is met with showing only this double nature of the primitive streak posteriorly.

Regarding simply the case in which the two embryos are complete and separate from one another, there are perhaps three ways in which it might possibly be supposed that the result has been brought about. First, as in the case of *Lumbricus trapezoides* division of the, at first single and normal, embryo may have taken place after a certain stage of development has been reached. It is difficult to imagine how this could have been produced; had it been so, the yelk and the area pellucida and opaca would have shown some trace of division. Secondly, it might be supposed that the two embryos were due to the existence of two distinct nuclei, enclosed abnormally within the protoplasmic material constituting one ovum. In contrast to the usual method of formation of the germinal cells in Craniata out of a number of nucleated cells, which first become aggregated

* For teaching purposes, I have found it convenient to relinquish the old form of nomenclature according to which chick embryos were designated by the number of hours of incubation—a most unsatisfactory method, since different eggs incubated for the same length of time will often yield embryos of various stages of development. I have instead adopted the method followed by Balfour in dealing with elasmobranch embryos, and according to which the stages of development are indicated by the letters of the alphabet. An account of these stages, with illustrative figures, is now in course of publication. The embryos here referred to are at the commencement of the stage which will be designated G.

into "nests" having the form of masses of protoplasm containing nuclei, the "nests" becoming subsequently constricted off into distinct cells, it might be supposed that two nuclei became enclosed in a common mass of protoplasm. In this case, even supposing that each nucleus became united with a spermatozoon, we should expect to find two distinct blastoderms formed, an occurrence which has not as yet been noted.

Thirdly, and most probably, it may be supposed that the very first division of the nucleus was abnormal. The nucleus may have become divided into two halves, which were qualitatively and quantitatively precisely similar, and not, as we may suppose to be the case in normal division, slightly different from each other. Probably, in the normal development of at all events the higher form of life, from the very first division of the nucleus and protoplasm, parts are produced which differ minutely from each other, and neither of which, if placed in suitable circumstances, could give rise to a perfect animal. Abnormally, we may suppose that division takes place in such a way that the two half nuclei are *exactly* similar to each other, when further development may, under suitable conditions (*e.g.*, a sufficient mass of nuclear material remaining in each half, and a sufficient supply of nutrient material), result in the formation of two similar and fully-formed embryos.

This suggestion will also serve to account for the cases of incomplete division of the embryo, as in the one figured by Mr. Lucas. In these cases, abnormal segmentation, resulting in the production of two halves precisely similar to each other, only takes place at a later stage, and so only affects certain cells (and their nuclei), which will give rise to certain organs of the body. Hence, we get a duplicature of such structures; or, if abnormal division again follow, a still further multiplication of them. The further back in segmentation, that is the earlier this abnormal division takes place, the larger is the part of the body affected, until, if the division affect the segmentation nucleus of the ovum, the result is two complete and separate embryos.

ART. XVIII.—*Address at the Inauguration of the Literature and Art Section of the Royal Society.*

By ARTHUR S. WAY, M.A.

President of the Section.

In his recently published "Letters on Literature," Mr. Andrew Lang, with a touch of that fine superciliousness, that fashionable air which your critic affects now, observes: —"Can anything speak more clearly of the decadence of the art of poetry than the birth of so many poetical 'societies?' . . . They all demonstrate that people have not the courage to study verse in solitude, and for their proper pleasure; men and women need confederates in this adventure." "Demonstrate," do they? Because, forsooth, it is inconceivable that they may be the outcome of real earnest interest and devoted study, which bears fruit in desire for communion with kindred minds, for the give and take of thought and criticism, that so the golden sands of the stream of song may yield up the more treasure. And does the birth of a microscopical society "demonstrate" that men will not investigate alone, or the birth of a musical society that they cannot sing and play in the privacy of home? Is it too flattering to human nature to imagine that people may wish to meet to interchange ideas upon what interests them deeply; that it is not mere hypocrisy which brings strangers together, to be thenceforth made friends by the strong bond of common intellectual pursuits and tastes? Is this feature of our time something strange and wholly new? Not so, but it is a genuine rational endeavour to supply that which our fathers enjoyed, but which altered social conditions have made unattainable, under the same form, in these days. The nights at the "Mermaid" are fled beyond recall; nor will men gather any more, as once they gathered, round "glorious John" enthroned at Will's; nor will such discourse of gods be again heard, as when the coffee houses knew Johnson and

Goldsmith and Burke. Yet we are not, therefore, behind our fathers in love of intellectual culture, and it is a pitiful cynicism which can see in literary societies only a sham enthusiasm, an attempt to galvanise into a semblance of life the taste and interest that have long been dead. Rather is it matter for surprise, that for years past there has been in Melbourne no society having for its object the study of literature and art. There have been Browning and Shelley societies; there is—to the astonishment and confusion of the critics who croaked at its birth—a Shakspeare Society, flourishing in vigour still; there are also divers associations of skilled votaries of music and art—these, however, are almost professional in their character; but for those who can pretend to no special gifts or training, there is no place and little interest in these. And meanwhile the world's inspired work goes on; its poets sing as seldom they have sung in times past; its romancers weave their wonder-webs; its musicians, now as in Shakspeare's day, "hale men's souls out of their bodies;" its painters kindle the light that never was on sea or land; and of all this each of us sees and hears and notes a little, in fragments, overlooking much, and missing the significance of more, forming half judgments, and receiving fast-fading impressions. In casual meeting with friends who are like-souled, he may compare thoughts, and find how much of the past and the present a solitary reader is in danger of missing, and may taste how good a thing it is to interchange ideas, and to tell and hear of pilgrimages into the fairyland of mind, and to discourse together of work that will endure, of names that will be enshrined, of ever-living presences that will be enthroned long after the sand-ripples of politics have been a myriad times washed out and re-moulded by the tides of time, and the babble of society gossip is become as the withered leaves that fluttered to the ground in forgotten autumns.

To substitute for such casual communication of thought some system of mutual help and guidance, to gather and focus the literary interest of a great city, to make something nobler than a coterie, something more unselfish than a clique, was the aim of those who proposed to quicken into life this literature and art section of the Royal Society of Victoria. There is something peculiarly British in the instinct for the old paths, which prompted them, not to burst upon the world with a new society of imposing title, but to awaken a

long dormant potentiality of the good old Royal Society. Few of the two score members who have attended—or of the ten score who have stayed away from—the meetings of this respectable body, have bethought them that beneath its ample wing there was room for any nestlings but such as chirped abstrusely of biology, chemistry, physics, and all that stern sisterhood of science, who are not to be wooed save with tireless toil of research, with concentration of knitted brows, and libations of midnight oil. At meeting after meeting we sat and listened while our betters threaded labyrinths of theory, and shot out waggon loads of facts, lightly gliding through mazy calculations, or glibly "chattering stony names." We hearkened diligently with much heed, if haply we might gather for ourselves a few crumbs from so plenteous, and so indigestible, a feast. And still we gazed, and still the wonder grew, as other Anakim rose, and discussed and criticised off-hand these miracles of abstruseness, put what seemed to be pertinent questions, and with Burleigh-nods received answers which, for us, "made the case darker, which was dark enough without." But not even the genial aspect of our president, as he sat wearing all that weight of learning lightly like a flower, could embolden us to rise and reveal our abysmal ignorance by question, much less by criticism. We were in our own sight as grasshoppers, and so we were in their sight. There was something depressing in being thus, as it were, mere cumberers of the ground, the one excuse for the impertinence of whose existence lay in the hope that our annual subscriptions helped to plume the wings of science for soaring far above our ken. Then some one spoke his open-sesame at a long-sealed door, and behold, we also had a mission!

And now that our vocation is revealed to us, we perceive that we can never be at a loss for lack of material whereon to work. For, passing by for the present music and art, as being as yet but doubtfully represented amongst us, the whole range of literature lies before us as our field of study. Homer is not too remote, nor Browning too near. Nor poetry only, but fiction, with—shall we say, including?—history and biography; the long result of time in scholarship and criticism; the thoughts that shake mankind in theology and philosophy. The mine is inexhaustible; how we shall work it, we see as yet but dimly. We may remark at the outset, that the main object of our co-operation must be to furnish incentives and aids to reading and reflection.

It may be accepted as an axiom, that no amount of criticism or discussion of a book, if it is worth reading, can serve as a substitute for reading it, and if it is not worth reading, it is not worth talking about. Unless, therefore, the papers that will be read at our meetings, and the discussions that will follow, stimulate us as individuals to extend our acquaintance with literature by personal study, the work of this section will be but a casting of seed by the wayside, for nothing is more evanescent than knowledge picked up from mere talk about a subject, nothing more fleeting than the interest so excited, if it be not followed up by earnest, fruitful research.

This outcome of our work must, of course, depend almost entirely upon members individually, but it is well that they should understand that one for whom our meetings constitute, not the salt, but the food of his literary life, is not only surrendering the substance for the shadow, but is thwarting the very object for which we co-operate. For it must be recognised, that the work of a literary society does not stand on the same footing as that of a scientific society. The latter is, to a considerable extent at least, concerned with original discovery; and every minutest observation, every lifting of a corner of nature's veil, may prove one more fresh addition to the mass of details, the accumulation of which by a host of patient investigators is providing the heritage of posterity, the hope and prophecy of science, the solution of the riddle of the earth. And in no country can the work of the biologist, for example, be more important than in Australia now, while yet so many ancient and unique types remain which are doomed to disappear before the advancing tide of settlement. The searcher into nature may be said to be working against time; every moment may be precious, as bringing an opportunity irretrievable if lost; every find may be pure gold, as he rescues vanishing links and gathers up failing clues, for lack of which the men of future days would grope in darkness and twist ropes of sand. He heaps up riches, and if he knows not who shall gather them, at least he knows that they surely will be gathered, and that the harvest will be many times the richer for every grain saved now.

But we of this section of the society are not so much wealth-heapers, as wealth-users. We look to rescue no waifs from antiquity; we shall not unearth treasures of archæology; the voices that call out of the past will scarcely reach us first, nor will it be ours to place new leaves on Clio's brow. It

may well be that our tribute to the world of scholarship and criticism will be insignificant, nor do we flatter ourselves that the thinkers of far-off lands will ever learn to wait till we have spoken. But we need not, therefore, underrate the importance of our actual work. If self-culture only were the end and aim of our association, there would be ample justification for this section's existence; for as no man liveth to himself, whatsoever be our gains in freshness and depth of thought, in wealth of widened culture, and clearness of intellectual vision, we win for others also. From the quickening of a man's mental powers, a magnetic influence thrills those with whom he mingles, nor does he, in rising, wholly leave his fellows behind. But this indirect and insensible influence is not the limit of our hopes; we trust, even in this our day of small beginnings, to render more direct service to the community, and to take a more active part in meeting the needs of our generation. It is no new observation, that to the life and thought of this Colony the poet's words are peculiarly applicable, "The world is too much with us, late and soon getting and spending we lay waste our powers." We claim no right to make this a reproach to our fellow citizens, nor to look upon them as from a pedestal of superiority. The rush of the tide of commerce, rising almost too fast for our financial argosies to ride its crest, the imperious stress of business, the merciless strain of competition, the bewildering swiftness with which vistas of opportunity open on every hand, the eager energy of a young community pressing in the first flush of its vigour ever on to new conquests, the thrilling consciousness that we are here laying the foundations of an empire, and doing a mighty work for ages unborn—all this makes it seem less strange or sad, that men should fancy that these interests claim all their thoughts and powers; that when art and literature are beckoning, they should think that they do well to reply, like the sternly earnest builder of old time, "I am doing a great work, so that I cannot come down. Why should the work cease whilst I leave it and come down to you?" It is not obvious to all, but only by experience do men learn that the pursuit of culture is no hindrance, but a secret help in the race for worldly success, that wealth of intellect makes material wealth more valuable when won, widening the range of its application, and creating taste and refinement in place of vulgar profusion and senseless display. We cannot too steadfastly believe, nor too earnestly proclaim,

that the pursuit of gain, the struggle for existence, must not be all-absorbing, lest, when the goal is attained, we find that the hard-won rest is a joyless old age, an aimless *ennui* of weary years. It is a physiological fact, that the bodily powers will be the sooner worn out by toil if the intellect meanwhile is rusting out, if its faculties are not stimulated and exalted by what is at the same time a rest and a refreshment, which "will keep a bower quiet for us, and a sleep full of sweet dreams and health and quiet breathing." We hope, therefore, to attract into our society some world-weary toilers, who, as they accompany us on our pilgrimages into regions of thought and imagination, may find a charm and peace as of green pastures and still waters.

Our primary object being to arouse and foster an intelligent and appreciative interest in the best literature of the present and the past, we have bound ourselves beforehand to no stereotyped method of procedure. A series of papers, each followed by such impromptu discussion as their subject-matter and treatment may provoke, is a very common feature of such meetings as ours; but if it becomes the rule, it has this disadvantage, that, as few will undertake the trouble of preparing such papers, in process of time the work falls into the hands of a small section of the society, the rest becoming mere listeners, who, for want of previous acquaintance with the subject-matter of a given essay, are generally unprepared even to take part in a discussion of it. Hence we must endeavour to contrive that sometimes papers shall grow out of previous common readings and discussions. It may be arranged, for instance, that on a given evening shall be introduced to the society the latest work of some great author. It is not too much to expect that the reading and conversation of that meeting will secure for the next a number of short papers on his style, on the growth of his genius, his place in literature, his influence, his "school," and so forth. Again, we might have an occasional meeting at which each member would be pledged to appear, armed with a short criticism, or notice, though it be but half-a-dozen lines, of a work recently read by him. We shall shall thus furnish each other with suggestions and guidance for reading, and be also cultivating a discriminating, critical spirit in our reading. Bacon's aphorism will ever be true, that "writing maketh an exact man," and if we from time to time practise formulating our impressions, and recording our judgments of our reading, we shall be cultivating that

tracery; but alas for us, and alas for him, if bronze and marble shall know him no more. Is it the beginning of the end? Are the voices but singing on, when the spontaneity, the heart-throbs, have gone out of the song, and the wings of genius have flagged? or is it but a pause of midsummer twilight, the falling of shadow that shall quickly be scattered by a new dawn? Who shall say? Ever and anon a brief outburst reveals that this singer and that can still put forth the old soaring power, the old fire, and we wonder whether it is weakness or wilfulness which makes these nobler notes so short and so far between. This interval which we seem to have reached suggests this as a favourable time for a review of the present aspect of English poetry as represented by our chief living singers.

The roll of the leading poets of to-day is one throng of splendid memories, it means to us thirty years of unsurpassed achievement, years resonant with melody, and rich with romance, thrilling with high-wrought passion, and rapt in noble visions and deep heart-searchings; years in which poets' dreams were as the dreams of seers, and their speech like the crying of prophets. Noble themes and earnestness of utterance were the key-notes of those years, and it is just because these characteristics can never seem to be lost beyond recall, but to be resumable at the choice of the poet who has yet the power to sing, that we hope on against hope, that each next volume may herald the flowing of the tide once more.

From the time when Tennyson stormed the hearts of men with "In Memoriam," and wrought the world to "sympathy with hopes and fears it heeded not," his muse has always trod the mountain heights, as though conscious of a great mission, of powers consecrated to the help of brother men. We have stood with him beside the tomb, and seen the angel of consolation reach a hand through time to catch the far off interest of tears; we have watched with him the sun of a noble purpose set in a stormy sea, and have learnt that defeat is not failure, nor any striving against evil vain. With him we have found love in huts where poor men lie; we have from him learnt sympathy with the egotism of man's passion, with the fever of woman's unrest, with the despair of unfaith, and the night of hopeless anguish: little children that lie on beds of pain are nearer to our hearts
him; and England is stronger to-day for the battle
at remind us that we are of kin to heroes.

understood as pressing this upon your attention to the exclusion of all else, but as constrained by limitations of time and space to deal with but a little corner of a vast area, and as wishing to indicate, from the abundance of this, what measureless wealth lies beyond.

The first thing that strikes us in connection with what we may call the Victorian era of literature, is its marvellous activity, the multitude of workers, and the rapidity of production. We have often heard how England became, in the days of Elizabeth, a nest of singing birds; the same might be said, perhaps with even more truth, of our own Queen's reign. The revival which began with Cowper, and which received a Titanic impulse from Scott and Byron, from Wordsworth, Shelley, and Keats, is unexhausted yet. The oldest poets' songs still breathe and burn with the fire of youth, and a throng of others are yet in full voice. There is, however, one peculiar and ominous feature. Speaking generally, no work of any of these, produced during the last ten or twelve years, has been an advance on their previous work, and in some instances there has been a decided falling off. This is not only the case with those to whom fulness of years might be expected to bring some decay of strength, but with those who should now be in the full maturity of their powers. In these latter, we observe a tendency to work more and more artificial, where diction and expression and technical effect are more than ideas; a tendency to imitative work, reproductions of old styles, to the neglect of originality. The execution is certainly wonderfully perfect, not a slip or a false note anywhere; but the lines make you think of engine-turned jewellery. As you read one page, you know what to expect on the next. There are no surprises, and when you pause from reading two or three score pages of this machine-made poetry, and try to recall one thought that has lifted you out of yourself, one hint that has lured you into dreamland, one touch that has "oped the sacred source of sympathetic tears," and find only a certain tired wonderment, as of one who has sat through an evening of conjuring tricks, then it dawns upon you that the wonder is nowise wonderful, nor the perfection of work perfect work. The poet has but to take care of the sound; there is so little sense that it can easily take care of itself. Years ago the sculptor fashioned divine marble and deathless bronze; delicate cameos and dainty gems engross him now, and seldom has gem or cameo borne such fairy

to the grim captain's iron discipline, and so have these days beheld the mules of Browning, for whom no load is too merciless, no path too rugged for their patient plodding. They receive with humble gratitude his periodical bounties, and stolidly proceed to put them through the mill of interpretation and analysis, more than rewarded if they can proclaim that they have found a meaning. The Browning societies are a very doubtful blessing to their poet, for their tendency is to disguise the fact that to the world generally he is to a large extent unreadable, and, if he regards them at all, to confirm him in a course which may sorely thin his wreath of immortality. If it be objected that each poet has a right to his own style, and is under no obligation to stoop to a popular level, it may be answered, first, that there is no "stooping" implied in returning to the style of what even his votaries acknowledge as his noblest work, and which has a depth and clearness like Shakspeare's; secondly, that a great poet, dowered with a gift whereby he may raise and purify and inspire men's souls, whose song may be strength to the weak, comfort to the sorrowing, companionship to the lonely, and a spur to high endeavour—such an one owes to his fellows a free and generous recognition of the principle that "none of us liveth to himself." There is no poet whose disregard of it could be a greater loss to the world, for since Browning's special gift lies in the analysis and presentment of character, and since he has an inborn affinity for what is noble and true and strong, and since he holds with an unfaltering grasp those vital truths which deeply concern all men, and since in a day when the sensuous, the revolting, the unmoral assert their claim to the thrones of Valhalla, he is ever a witness for what is pure and lovely and of good report, it is of the highest moment that every stroke should tell, that the trumpet should give no uncertain sound, that the prophet should not speak in riddles nor babble in an unknown tongue.

To attempt to arrange in order of merit, like so many boys at a school, the great writers of any period, would be both futile and misleading; for, on examining their work, we find that their genius is at bottom dissimilar. It has an affinity for different subjects, and even should these be based on identical events or phenomena, it at once cancels the apparent identity by taking a different point of view, by selecting different features as most important, by a different moral attitude to the subject, and by singing the song to

different music. No one author ever exhausts the possibilities of noble treatment of a theme. Browning may go to the heart of it if he will, but there is that in it which it is not for him to win, and which may through another become to us a precious possession for ever. From the same mine whence he has dug diamonds, Tennyson will bring forth sapphires, Swinburne rubies, and Morris emeralds. There is no classifying; each sings his mighty song, and for each there is a several multitude of listeners whose spirits are most attuned to his, who take his best and let his worst pass, knowing that it is not truly and essentially of him. If we think that a subject appeals to Tennyson through its connection with human sympathy, the hopes and fears and strivings of men; to Browning through the scope it gives for mental analysis and the search for fundamental truth, we might imagine that it appears to Swinburne not as plastic material at all, but as a living thing, that it touches him with an electric shock, flashing on him a sudden vision of mystery and terrible beauty, sweeping around him a tempest of passion, in which motives and their working may be vaguely defined, and the sequences of thought be blended and confused. While other poets enter into and possess their subject, he seems rather to be caught up and possessed by it. Hence he comes nearer to the old conception of the poet, who, as Plato puts it, "creates his work not by wisdom, but by a certain might of nature and frenzy of inspiration, like soothsayers and prophets." It can be no prosaic age which has born and fostered this Pindar of passion-song, this singer of the heart's storm and the spirit's rapture, those rare moods of exaltation when we are like unto them that dream, when we tread on ether and think by lightning gleams. It was fitting that in command of his instrument, the rhythmical resources of language, in mere word-music, he should be wholly without a rival. He has revealed capacities for melody in our tongue that were unsuspected before. Over his strings our stubborn English floats softly as Italian, and trips daintily as lyric French, and swells with an oceanic surge and thunder that we had despaired ever to win from Greek. Ever since, five-and-twenty years ago, he shook our pulses with the thrilling sweetness of that hunting chorus in "Atalanta in Calydon"—

> "When the hounds of Spring are on Winter's traces,
> And the mother of months in meadow or plain
> Fills the shadows and windy places
> With lisp of leaves and ripple of rain"—

his harp has never been hushed, has never given forth a tuneless note. In swift succession followed the lawless beauty of "Poems and Ballads," immature in thought, and nowise meet *virginibus puerisque*, but in execution perfect; the mingled trumpet-blast and organ-roll of "Songs before Sunrise," and the other poems inspired by the same theme. Scarcely a year has passed since then without fruit of his exhaustless fancy, his wonderful versatility. Powerful dramas, some of them of most portentous length, rhapsodies of the sea, romance of Arthurian legend, echoes from the lutes of old France, revivals of old Border ballad song, marvellous achievements in forms of verse once exotic, but now made English; the apotheosis of the baby, the Armada's triumph pæan—he has proved his strong pinions in all, and has shown that he has soaring imagination, vigour of expression, and staying power enough for the grandest theme. A little cloyed with sweetness, a little surfeited with melody, a little weary of high-pitched passion, a little impatient of endless roundels and ballades and invocations to his latest idol, the babe, we would fain see him rise from sporting amid flowers and toying with antiques to crown with a worthy wreath the head of that dear England whom he has often hailed with song since eighteen years ago he cried—

> "O thou, clothed round with raiment of white waves,
> Thy brave brows lightening through the grey wet air,
> Thou lulled with sea-sound of a thousand caves,
> And lit with sea-shine to thine inland lair,
> Whose freedom clothed the naked souls of slaves,
> And stripped the muffled souls of tyrants bare."

Surely there is inspiration enough in her heroic past, "the centuries of her glorious graves," in the Titan-tasks of her present; will her noble story not quicken, will the love of her not uplift, a great poet to do for her what Homer did for Hellas, what Virgil did for Rome?

When, twenty years ago, the tale of the "Earthly Paradise" followed on that strong sweet poem, the classic romance of "Jason," men became aware that the star of Chaucer was re-risen, that such a poet story-teller had come as England had not known for 500 years. William Morris took the old-time legends of Greece and Italy, of the Orient and the Northland, and married them to immortal verse—verse flowing clear and limpid as an unpolluted river, musical as a mountain stream. His strings were

never shaken by a wind of passion, nor his song perplexed with strange doubts and obstinate questionings—

> "Glad, but not flushed with gladness,
> Since joys go by;
> Sad, but not bent with sadness,
> Since sorrows die."

His muse, with far-away eyes, and heart unheedful of the life of to-day, seemed like a fairy godmother crooning by a prince's cradle the songs of Elfland, with effortless even flow of murmuring melody—

> "Like of a hidden brook
> In the leafy month of June
> That to the sleeping woods at night
> Singeth a quiet tune."

But "that strain we heard was of a higher mood," when, with a fresh keen wind from the Northland, with blast of war-horns and clash of sword and shield, "The Story of Sigurd" came as a revelation of strength and earnestness, of vigour and fire, of which he had given but half-tokens before. The swinging gallop of its sonorous lines, the unbroken maintenance of the "grand style" throughout, the heroic cast of thought, the wealth of incident, the energy of its magnificent battle-scenes, marked it as the most Homeric poem in the range of English literature. It was its author's high-water mark; he has since then been more and more spreading his powers over many interests, and his latest work of this year, "The House of the Wolfings," is rather like an ancient saga than a poem. In stately rhythmical prose, broken at intervals by speeches in the "Sigurd" metre, it tells the tale of the gallant stand made by our forefathers beyond the Rhine against the legions of the empire. Morris may yet give us much beautiful work, fascinating and perfect in its kind, but he has not taught us to credit him with the manifold possibilities of Tennyson, Browning, and Swinburne.

A very noteworthy characteristic of the poetry of the hour is profusion. The days are gone by when bards climbed Parnassus with slow and cautious step, giving good heed to their foothold, when Goldsmith thought ten years not too much for the production of the few poems and dramas which the world cannot forget, when Gray bought his eternity with the reading of one little hour. Now they go up the Aonian Mount by leaps and bounds, and reap the laurels with a bill-hook. There must be natural richness in the soil which (to change a familiar

metaphor) every time it is hurriedly tickled with a pen, laughs into such stintless harvests. Poppies and tares among the wheat, of course. No matter for that; posterity, which has plenty of time, may sort them out. And no one shivers with a premonition of doom, doubting what manner of sorting that will be when men gather the bundles for the burning. If Browning is profuse through crowded abundance of ideas, Swinburne through affluence of fancy and lordship over language, and Morris through wealth of material and facility of utterance, we might say that Robert Buchanan is so because he is in earnest about everything but writing good poetry; Edwin Arnold because he thinks that the "Light of Asia" has cast a glamour over men's eyes that will last his time, "and look a rosy warmth from marge to marge" of his exotic gardens; and Lewis Morris because he thinks—or shall we dare to say because he doesn't think?

Buchanan as a singing voice has been silent for some seven years, but between his twentieth and his fortieth year he poured forth verse enough to float—or swamp—three reputations. With no reserve or self-restraint, opening his heart to all the world, troubled by no misgivings as to his capacity to adorn any class of subject, he has roamed from classical studies to Scottish idyls, from "Phil Blood's Leap" to mystic transcendentalism. In "Idyls of Inverburn" and "North Coast" he struck his richest vein, full of perfect pastoral beauty and tender human sympathy, the pathos and the dignity of poverty and suffering. In "White Rose and Red," he essayed an Indian idyl, and in "Saint Abe" a Mormon romance of the Bret Harte type, with a success the spuriousness of which it takes an American eye to detect. But what Mephistopheles at his elbow prompted him to poetise Scotch metaphysics in "The Book of Orm," or to out-Shelley Shelley in "Napoleon Fallen"? There is no poet to whom the paradox is more applicable, "If he had written less, he would have written more." Akin to him in sincerity of conviction and in early promise was Jean Ingelow, whose voice rose like the song of a lark from daisied meadows, just as the nightingale notes of Mrs. Browning were for ever hushed. Her lyrical idyls were full of the music of sunny brooks and vocal English hedgerows. Among the cottage homes of England, her voice rang very sweet and true. There was surely variety and human interest enough in these for a life's work. She has not enhanced her fame by recent more ambitious efforts.

"The Light of Asia" was a great success, as it deserved to be. The richness and sublimity of Oriental poetry, without its vagueness and diffuseness, were there embodied in verse that was perfect of its kind, that was to Tennyson's as the floating grace of Aphrodité to the imperial tread of Pallas. It was, in the words of an almost forgotten poet, "a poem round and perfect as a star." There were even people to whom it came as a new gospel, and Buddhism became the cult of some Bostonian enthusiasts.

But the "Song of Songs" and "Pearls of the Faith" are far below it. They are fragmentary, without sustained interest, they are cabinets of "specimens," or albums of "beauties," they bristle with unpronounceable names, and recondite allusions; they do not read as if the thought of a far-off age and country had been passed through the crucible of a poetic mind aglow with inspiration. The fascination of their forerunner drew you on and on, till, when you reached the end, you wished the poem longer; you must be a proselyte indeed if these charm in like manner. It would seem that Sir Edwin must keep touch with Eastern fancy and imagery, or he is lost; for never did a poet who had once achieved a name, blunder into a more melancholy waste of commonplace, a flatter Batavian landscape of prosy rhyme, than he, in the volume with which last year he attempted to vindicate his claim to a place among singers of English song. If, as some have conjectured, it was a bid for the reversion of the laureate-ship, it must have been based on the theory that the office would be disposed of by Dutch auction. There is a fortunate resumption of the Oriental sumptuousness of fancy, now blended with the pathos of sorrowing love, in the just-published "In My Lady's Praise," an acrostic poem which takes up successively the precious stones whose initial letters spell the name of his dead wife.

It has been the misfortune of more than one of our prominent poets to be betrayed by success in one field into failure in another. Tennyson's mastery in development of character and human sympathy led him to tempt the gods in writing acting dramas. Edwin Arnold's success in piloting splendid argosies from the East, a rich storehouse of romance and mystery, entrapped him into producing original poetry out of his own head, which no one had suspected of being so forlornly bare. Lewis Morris achieved popularity, even to the 23rd edition—as he is at pains to inform us—by the art

of re-telling old-time stories with picturesque fancy and in easy-flowing verse, an echo of Tennyson's; but the stroke of Nemesis fell heavily upon his head—albeit somewhat callous—when the great vision of life, the mystery of its passion and its pain, stirred him to soar into the clouds in a grandiloquent "Ode of Life," only to find, when at his highest, Tupper still a little above him. The public ear had become attuned to Tennysonian melodies and Tennysonian meditativeness when the "Songs of Two Worlds" and the "Epic of Hades" appeared, and (in advertisement phrase) "supplied a felt want." For here were poems, tender and graceful, to comprehend which entailed no intellectual strain, and which could be read without a mental effort—and the public likes to do its reading without thinking; poems not too deep and nowise dry, where wealth of sunny fancy disguised poverty of high imagination, and plenty of whip consoled Pegasus for being stinted of the divine fire. Had Morris maintained this level he would at least have been a charming poet, pleasant to read, in whose pages strictly moderate expectations would not be disappointed; but he fell below himself into mere book-making, and became often weak and washy, in "Songs of Britain," "Gwen," and above—or rather below—all, "The Ode of Life."

The grove of the muses is full of singing birds, and ringing with sweet, pure notes on every side, but they are mostly imitative, echoes, or variations upon the strains of our mightier singers. The only distinctive class as yet unnoticed, is that of what we may call the "drawingroom poets"—the writers of society verse. These are of the lineage of Suckling, Lovelace, and Waller; they have caught up the lyre that fell from the hands of Praed. Their work, in its perfection, is marked by elegance of finish, by lightness of touch, and by rapier play of wit; an art concealing art most cunningly. Seriousness, of course, is alien from their whole atmosphere. They seem, as it were, born out of due time, and to belong of right to the days when patrician beaux fluttered and flaunted with diamond snuff-box and priceless ruffles through the glittering *salons* of Queen Anne. They have captured and haled at their chariot-wheels the forms of old French Court verse, marvels of daintiness and difficulty, the ballade, the villanelle, the roundel, the triolet, and all their fairy company. Of these graceful triflers, who are so numerous as to constitute a salient feature of what is, perhaps, our transition period, Austin Dobson, Edmund Gosse, and Andrew Lang, are

foremost. "Proverbs in Porcelain," "Ballades in Blue China," and "Rhymes à la Mode," are titles which aptly indicate the nature of their contents. It may be doubted, however, whether there is not something suicidal in collecting such trifles in book form. To come upon occasionally and unexpectedly, and amongst graver reading, they are charming; but marshalled side by side, like linnets ravished from their native copses, and crowded in a cage, they quickly pall upon you. It is a banquet wholly of syllabubs, and you soon feel very hungry, and there comes to you, like a wicked whisper, that epigram of the old satirist, which seems to have a cruel applicability to the author—

> "As skilful divers to the bottom fall
> Faster than those who cannot swim at all;
> So in this way of writing without thinking,
> Thou hast a strange alacrity in sinking."

Andrew Lang, in the work already quoted, says, "Now we dwell in an age of democracy, and poetry wins but a feigned respect, more out of courtesy and for old friendship's sake than for liking. Though so many write verse, as in Juvenal's time, I doubt if many read it. 'None but minstrels list of sonneting.'" Just so; the public is quickly sated with rhyming for rhyming's sake. But when what is both good poetry and good reading appears, it counts its readers by thousands; but while poets write to please themselves, to practise their hand in quaint measures, to catch far-off echoes from old lyres, to reproduce the outward shell of a past century's thought, while they give us the barren blossom of an airy fancy, the devices of a fine-strung ear, but do not dig deep into their own hearts, nor speak as those who are stirred with strong emotion, or lifted by mighty inspiration to utter things irrepressible, they need not wonder, they should not complain, if the world cares as little for their trifling as they for the world's needs.

I have thus briefly touched upon one department of the literature of our day, and that only in connection with living poets, of whom we may expect more, and for whom there is yet hope. I had intended to glance at fiction, biography, history, the drama, and so on; but these must needs wait a more convenient season, and, perchance, a more experienced critic. I do not flatter myself that my audience will accept all my conclusions without demur. In poetry, which is pre-eminently a matter of taste, each reader will find his own affinities, and will know what best appeals to him.

> "'Tis with our judgments as our watches, none
> Go just alike, yet each believes his own."

ART. XX.—*Report of the Port Phillip Biological Survey Committee*, 1889.

Members of Committee :—W. M. Bale, F.R.M.S. ; Rev. A. W. Cresswell, M.A.; A. Dendy, M.Sc., F.L.S.; P. H. MacGillivray, M.R.C.S.; Professor W. Baldwin Spencer, M.A. ; C. A. Topp, M.A., F.L.S. ; J. Bracebridge Wilson, M.A.; A. H. S. Lucas, M.A., B.Sc., Hon. Secretary and Treasurer.

Your Committee has continued its operations during the year. The grant of twenty-five pounds was devoted to the purchase of spirit and jars, which were sent to Mr. Wilson to assist him in his work near the Heads.

At the close of the season, Mr. Wilson forwarded his collections, which are very valuable, to the Biological Laboratory of the University for distribution to the specialists.

Certain of the specimens thus obtained, as also others collected previously, have been sent to the specialists for determination and report. Others are packed and ready to be sent, and your Committee would ask for a further grant of ten pounds to defray the expenses of transmission.

Reports have been received from Professor W. Hatchett Jackson, of Oxford, on the Pycnogonida; from Dr. S. J. Hickson, on the Alcyonaria and Zoantharia; and from Mr. Lucas on the Fishes. These will be ready to appear in the ordinary course of publication. In all these groups, new species have been determined and described.

Mr. Dendy has devoted much time and care to the study of our sponges, and we may expect from him a very full and valuable account of the taxonomy and anatomy of this difficult group.

Mr. Wilson has established a small Biological Laboratory and Aquarium at Sorrento, and opportunity will thus be afforded of studying some of the marine forms more satisfactory in the living state.

A. H. S. LUCAS,

Hon. Sec. and Treas.

December 1889.

(1) *Preliminary Report on the Crinoids obtained in the Port Phillip Biological Survey.*

By P. H. Carpenter, D.Sc., F.R.S.

In the Summer Season of 1887–8, a number of Crinoids were dredged in the outer stations of Port Phillip, and from outside the Heads, all of them by Mr. J. Bracebridge Wilson.

Twenty-nine specimens were forwarded to Dr. P. H. Carpenter, F.R.S., who has obligingly sent us early information, notwithstanding his pre-occupation with other work.

Dr. Carpenter considers that five species of Comatulæ are represented, viz :—

Antedon pumila, Bell. 14 specimens.

A. wilsoni, Bell. 4 specimens.

A. macronema, Müll. sp. 2 specimens.

A. sp. nov. (prob.) 5 specimens.

Actinometra trichoptera (Vall.) Müll. sp. 4 specimens.

A. pumila was described by Prof. F. Jeffrey Bell, in the *Alert* Report, from Port Jackson. By some confusion, when he received, later on, Port Phillip specimens from Mr. Wilson, similar to those sent to Dr. Carpenter, he described them as new, under the title of *A. incommoda*. In a recent letter to Mr. Wilson, Prof. Bell writes:—"I am sorry to say that *Antedon incommoda* is a synonym of *A. pumila* from Port Jackson. There will be a note on the subject in the next Annals." (A.M.N.H., March 1889).

Dr. Carpenter adds, that the originals, both of *A. pumila* and *A. wilsoni*, and also of *Actinometra trichoptera*, were sent to Prof. Bell by Mr. Wilson. They were not known from Port Phillip before Mr. Wilson's dredgings.

The novelties of our consignment to Dr. Carpenter are, the first record of *Antedon macronema* from Port Phillip, and the occurrence of a form, which "I believe to be a new species; but it may turn out to be only a strongly marked variety of *A. pumila*."

Dr. Carpenter adds, "I have a large number of undescribed species in hand from various localities and collections; and as soon as I have finished the Report on the *Blake* Comatulæ for Agassiz, I shall tackle them for the Linnæan Society; and I shall take the opportunity then of properly figuring your *A. wilsoni*, and also *A. pumila*.

"I wish very much that you could get me some larvæ of *A. macronema.* I want very much to study the development of the calyx, which is very Jurassic in its general characters."

The communication with Dr. Carpenter was made by Mr. Dendy, on behalf of the Committee.

(2) *Preliminary Report on a Collection of Alcyonaria and Zoantharia from Port Phillip.*

By S. J. Hickson, M.A., D.Sc.

In preparing this report of a small collection of Alcyonarians, sent to me by Professor Spencer, of Melbourne, on behalf of the Port Phillip Biological Survey Committee of the Royal Society of Victoria, I have met with greater difficulty than I expected. The numerous genera and species of Stoloniferous Alcyonaria, which have been named, are so imperfectly described and figured that it is almost impossible to identify specimens without seeing the type specimens. The greatest possible confusion exists as to the characters which separate the different genera and species, and consequently it is frequently found that similar specimens, probably belonging to one and the same species, are described by different authorities under different specific and generic names.

In the course of the last few months, I have carefully gone through the literature of the subject, and I propose shortly to communicate to the Zoological Society a paper dealing with the classification of the group.

Very few specimens of the genera Alcyonium and Ammothea have as yet been received in this country from Australian waters, and it might have been thought desirable to consider the two specimens (20 and 21) sent to me to be new species. I hope to be able to justify the course I have taken, in referring them to the species mentioned in the report.

The same difficulty is met with in considering the position of the Zoantharian genera, Palythoa and Epizoanthus, as mentioned above in the case of the Stoloniferous Alcyonaria. I believe there is not sufficient ground for the maintenance of many of the species which have recently been described.

(1)* *Virgularia lowenii* (Kölliker). "Anat. System. beschreibung der Alcyonaria," p. 182 *et seq.*

This specimen closely corresponds with the description of the species given by Kölliker.

* The numbers refer to those on the specimens sent to Dr. Hickson.

(2) *Telesto smithi* (Gray). "Annals and Mag. of Natural History" (4) iii, p. 21.

There are considerable quantities of this species in the national collection at South Kensington.

Specimens collected by H.M.S. *Alert*, Arafura Sea, 32-36 fthms; Port Holle, Queensland, 12-20 fthms.

(3) *Clavularia australiensis* (sp. nov.)

Specimen growing on the test of an ascidian.

Stolon thin; membranous plate-like, dividing into separate ribbon-like pieces at the edges.

Polypes 2mm. long, 1mm. diameter in average size; separated from one another by very slight intervals.

Colour, brownish-yellow, due in large part to a considerable deposit of fine yellow sand.

Spicules very few, or absent.

Vide general remarks at the beginning of the report.

(4) *Virgularia lowenii* (?)

I believe this specimen to be a young form of *V. lowenii*, see (1).

(5) *Mopsea dichotoma* (Lamx.) "Hist. polyp. flexibles," p. 467; *Isis dichotoma*, "Linn. Syst. Nat.," Ed. x, p. 799, *vide Challenger* Reports lxiv, p. 41.

The specimen agrees with the specimens obtained by H.M.S. *Challenger* at Port Jackson, 35 fthms.

(6) *Telesto smithi*, *vide* (2).

(7) *Clavularia ramosa* (sp. nov.)

Specimen growing on a much ramified Alga.

Stolon composed of a number of branched tubular strands, upon which stand at intervals of about 3mm. the polypes.

Polypes partially retracted (the calyx being withdrawn into the body of the polype); funnel-shaped (narrow at the base, broad at the extremity); in the retracted condition 3mm. long by 1½ diameter at the extremity.

Spicules numerous both in polyp walls and stolon, ·1 to ·15mm. long, double clubs and spindles bearing numerous prominent wart-like projections.

Colour, pale, dirty yellow.

(8) *Epizoanthus parasiticus* (Verrill). "Memoirs Boston Soc.," Vol. i, p. 34.

Vide Challenger Report vi, p. 116, by Hertwig; and Supplement to Report on Actiniaria, by Hertwig and Erdman, published in 1888.

Vide remarks on the species of Zoantharia at the beginning of the report.

(9) *Primnoella australasiæ* (Gray). "Ann. Mag. Nat. Hist." (2), Vol. v, p. 510; Wright, *Challenger* Reports lxiv, p. 88.
Specimens collected by the *Challenger* at Port Jackson, 30 to 35 fthms; Twofold Bay, 150 fthms.
Specimens collected by H.M.S. *Alert*, now in British Museum, in Magellan Straits, sandy bottom, 30 fthms, apparently belong to this species.

(10) *Epizoanthus parasiticus*, see (8).

(11) *Clavularia australiensis* (sp. nov.)
Specimen growing on a sponge.
Stolon, thin, membranous, plate-like, becoming divided at the edges into narrow ribbons.
Polypes crowded together in the central regions of the colony, scattered and separated by considerable intervals at the edge; partially retracted. The average length is 3mm., and the average breadth 15mm., but they vary very considerably in size.
Spicules numerous in the polypes, few and scattered in the peripheral portions of the stolon; ·2 to ·3mm. long; spindles with very prominent wart-like projections.
Colour, brownish-white.

(12) *Epizoanthus parasiticus*, see (8).

(13) *Mopsea dichotoma* (?)
A small fragment only of a Mopsea which apparently belongs to this species.

(14) *Telesto smithi.*
I can form no grounds for separating this specimen from *T. smithi.* It should be noted that some authors use, and with justice it appears to me, the stolon or root of the *Telestos* as one character useful for classification. None of the specimens submitted to me have this.

(15) *Gerardia* (sp.)
As a volume of the *Challenger* Reports, dealing with the large and interesting collection of the Antipatharia obtained by the expedition, is shortly expected, I have postponed the identification of this valuable specimen. It does not appear to differ very markedly, however, from *G. lamarcki.*

(16) *Sympodium verrilli* (Percival Wright and Studer). *Challenger* Reports lxiv, p. 271.
The specimen sent me is growing on a piece of Alga, and agrees fairly closely with the description of the species mentioned above.
The *polypes* are all completely retracted, a wart-like prominence, marked by an eight-rayed star, indicating their position.

These prominences are from 1 to 2mm. in diameter, rather smaller than those of the *Challenger* specimens, which are 2 to 4mm. in diameter.

The *spicules*, which are very varied in shape and size, are in general appearance similar to those figured by Studer (l.c. Pl. xlii, fig. 12).

The locality of the *Challenger* specimens is given as Station 320, lat. 37° 14′ S., long. 53° 52′ W.; 600 fthms.

(17) *Clavularia australiensis* (sp. nov. v. supra.) This specimen is growing on a piece of sponge.

Stolon thin and membranous, in some places forming sympodial plates, in others narrow ribbons. Numerous spicules in the older part of the stolon.

Polypes averaging ½mm. in diameter; all of them considerably retracted, leaving projections on the stolon 1 to 1·5mm. in height. They stand on an average 2mm. apart from one another.

Spicules as in (11), only more numerous.

Colour, brownish-white.

(18) *Clavularia australiensis.* A very small specimen, apparently belonging to this species.

(19) *Palythoa anguicoma* (?) A very small specimen apparently belonging to this species.

(20) *Ammothea thyrscides.* Klunzinger "Die Korallthiere des Rothen Meeres," p. 30, Part I.

This specimen agrees fairly well with the description given by Klunzinger.

(21) *Alcyonium tuberculosum.* Milne Edwards and Haime, Quoy and Gaimard, Voyage de l'Astrolabe Zooph., Pl. 23, fig. 4.

(22) *Clavularia australiensis.* Specimen growing on a Lamellibranch shell.

(23) *Palythoa anguicoma.*

(24) *Clavularia australiensis* (sp. nov.) Specimen growing on a broken piece of Mytilus (?) shell.

Stolon formed of thin membranous strands, in some places uniting together to form plates.

Polypes all completely expanded, 4 to 5mm. long.

Colour, white.

Spicules—I can find no spicules in this specimen.

(25) Missing.

(26) *Palythoa anguicoma.*

(27) *Sarcophyllum australe* (Kölliker). "Anat. System. beschreibung der Alcyonaria," p. 121.

The specimen sent me agrees in many of its anatomical details closely with Kölliker's species. The details in which it differs from it are such as might be expected in a young specimen. Kölliker's specimens varied from 196 to 262mm.; this specimen is only 115mm. in length. Kölliker's specimens possessed 32 to 47 leaves on each side; this specimen has only 28. The leaves of Kölliker's specimens bear four or five rows of polypes; the leaves of this specimen bear only two. In Kölliker's specimens there were numerous small calcareous needles in the leaves, and a few small needles in the stalk; in this specimen, I cannot find any spicules at all.

From the consideration of all these and other facts, I thought it better to refer this specimen to the species mentioned, than to consider it a new species, and give it a new name. It is very desirable to obtain more specimens of this pennatulid from the same locality. The only specimens hitherto obtained come from New Holland and Australia (*sic.*)

(28) *Clavularia flava* (sp. nov.)

Colony parasitic on old bivalve shell.

Stolon thin and ribbon-like, much branched, bearing a few polypes at intervals of 4mm. and upwards.

Polypes partially retracted; the calyx and tentacles are withdrawn into the lower part of the tubular body. Length in the retracted condition, 4 to 6mm.; diameter 1 to 1½mm.

Colour, bright orange.

Spicules orange-coloured, very numerous in both stolon and polypes; spindles club and double club-shaped, covered with numerous wart-like processes ·1 to ·15mm. long.

(29) *Primnoella flagellum* (?) (Studer). "Monatsbericht d. k. preuss Akad d. wiss., Berlin, 1878," p. 644; Wright, *Challenger* Reports, p. 85, Pl. xvii, 1.1a.

The very small specimen I received apparently belongs to this species, but it was too small and imperfect to identify with any degree of certainty.

MEETINGS OF THE ROYAL SOCIETY.

1889.

[N.B.—The remarks and speeches in the discussions are taken down verbatim by a shorthand writer, and afterwards written out at length with a typewriter, for reference and reproduction, if required; and therefore, more is seldom given herein than an indication of their general drift. If any person should wish to refer to the verbatim report, he can apply to the Secretary to the Society, who will give him an opportunity of perusing and copying it, or if he resides at a distance, so much as he requires will, upon payment of the cost of reproducing it, be forwarded to his address.]

ANNUAL MEETING.

Thursday, March 14th.

The President (Professor KERNOT) in the chair.

The PRESIDENT referred to the decease of Sir William Stawell, who, he said, was one of the original founders of the Society, under the name of the Philosophical Institute. It was instituted in or about the year 1857, and a list of members followed the rules, which were dated January 1857. The first name on the list was that of Sir Henry Barkly, who was then Governor of Victoria, and who took a great interest in all scientific matters. The next name was that of Sir William A'Beckett. Then there were the names of the late Sir Redmond Barry and others. Sir William Stawell was for a long time prior to his death a Trustee of the property of the Royal Society. He was also connected with many other bodies. He was a visitor to the Observatory from a very early period, and took an active interest in all scientific matters. Of late years he had not been able to attend the meetings of the Society. A debt of gratitude

was due to Sir William Stawell for being one of the founders of the Society. He would also be remembered at the University, where for some time he filled the position of Chancellor, and where the Stawell Scholarship was founded by him. He had passed away in the fulness of his years, and he would be missed in the scientific as well as in the political and judicial world.

Annual Report.

The Council of the Royal Society herewith presents to the Members of the Society the usual Annual Report for the year 1888. The following were the papers read during the Session :—

On the 8th of March, 1888, Dr. H. C. Wigg read the first "On the Proposed Introduction of New Diseases into Australia."

On the 12th of April, Mr. Robert Abbott's paper on "The Maintenance of Energy," was read by one of the Honorary Secretaries; and Mr. Newton E. Jennings' paper on "Irrigation and Water Supply in the Australian Colonies," was read by the President.

On the 10th of May, Mr. Thomas Wakelin's paper, entitled "An Experiment to show how the Earth is made to Gravitate Towards the Sun," was read by one of the Hon. Secretaries. Mr. A. Dendy read one "On the Anatomy of an Arenaceous Polyzoon;" and Professor Spencer read some "Notes on the Presence of a Fluke in the Egg of the Common Fowl."

On the 14th of June, Professor Spencer read a paper "On the Presence of a Pentastomum parasitic in the Lung of Hoplocephalus superbus." Mr. A. Dendy contributed "A List of all the Species of Sponges described by Mr. T. J. Carter, F.R.S., together with the latter's more important references to the Species described by other Authors;" and Professor Spencer read another "On the Presence of a Rare Cestode Amphiptyches in Callorynchus antarcticus."

On the 12th of July, Mr. T. S. Hall's paper "On Two New Fossil Sponges from Sandhurst," was presented by Mr. Dendy, and read by one of the Hon. Secretaries. Mr. Dendy gave "A Preliminary Account of the Anatomy and Development of Stelospongus flabelliformis." The President next described the Hawkesbury Railway Bridge, then in course of construction in New South Wales.

On the 13th of September (the August Meeting having been suffered to lapse on account of the Members being engrossed by preparations for the approaching Inaugural Meeting in Sydney of the Australasian Association for the Advancement of Science), Professor Masson read a paper by himself and Mr. J. B. Kirkland, "On Polyhaloid Salts of Organic Bases." Mr. Ellery, F.R.S., described a New Watkin's Aneroid Barometer.

On the 11th of October, the President gave a brief account of "The Rise and Progress of Steam Navigation," and exhibited William Symington's Original Model Steamboat, which had been furnished for the occasion by the Rev. Duncan Fraser. Mr. F. A. Campbell read a paper "On the Active Volcano on Tana, New Hebrides."

On the 15th of November, Mr. A. Dendy read a note "On some Actinian Larvæ parasitic on a Medusa from Port Phillip;" and the Rev. D. Macdonald's third paper "On the Oceanic Languages Semitic," was read by one of the Hon. Secretaries.

On the 13th of December, Professor Masson read a paper by himself and Mr. Kirkland, on "The Preparation of Alkyl-sulphine and Alkyl-phosphonium Salts;" and Mr. James Stirling, F.G.S., read one on "The Physiography of the Western Portion of the County of Croajingolong."

Your Council has to record the remarkably successful initial meeting in Sydney of the Australasian Association for the Advancement of Science in August last, and to remind the Members of this Society that the next meeting is to be held in Melbourne towards the end of the year, and it is hoped that no efforts will be spared to make the second gathering at least equal to the first.

Your Council has also to congratulate the Society on the change made in the form of the publications of the Society, a new Series of Transactions having been commenced with Professor Spencer's paper on "Megascolides australis" as the first number. This paper has been issued on the pattern of the Transactions of the Royal Society of London, and expense has not been spared to make it worthy of its prototype. The other papers will be published in the same form as preceding issues, but with the title of Proceedings, the term of Transactions being reserved for those demanding more elaborate treatment and style of illustration. It is

anticipated that ample materials will be furnished by the Port Phillip Biological Survey Committee, which is prosecuting its labours in a manner that promises to justify the expectation. A second grant of £50 has been made in aid of the Committee.

Your Committee regrets that, in view of the increased expenditure involved in this change, an application which was made to the Government for an increase to the yearly grant in aid, was too late in the year to be of any avail, and it ventures to urge upon the Society and the next Council the necessity of renewing the appeal to the Government immediately, as the cost of continuing such publications is quite beyond the present means of the Society.

Your Council considered it both due and advantageous to the Society to recommend the appointment of several distinguished scientific men in different countries as Honorary Members of the Society, and on the 15th of November, six gentlemen were duly elected by the Ordinary Meeting.

Your Council strongly recommends its successor to institute an early revision of the list of societies with which this Society exchanges publications.

Appended will be found the names of nineteen new Members and Associates, which have been added to the list during the year:—Ordinary Members—Mr. Richard Bastow, Mr. S. C. Candler, Mr. J. M. Coane, Mr. E. J. F. Love, M.A., Dr. Alex. Morrison, and Mr. W. H. Nimmo. Country Members—Mr. A. W. Dixie, Mr. James Ivey, Mr. Newton E. Jennings, C.E.; and Mr. Henry Shaw. Associates—Mr. Wm. Swan and Mr. James Wilson. Honorary Members—The Hon. J. W. Agnew, M.D., M.E.C., Hobart; Dr. Bancroft, Brisbane, Queensland; the Hon. John Forrest, C.M.G., West Australia; Sir James Hector, K.C.M.G., F.R.S., Wellington, New Zealand; the Hon. W. McLeay, M.L.C., F.R.S., Sydney; Mr. H. C. Russell, F.R.S., F.R.A.S., Sydney.

Jonkeer Daniel Ploos van Amstel (having gone to Europe), Mr. F. H. Baker, Mr. F. R. Godfrey, have resigned their membership of the Society, and one Associate (Mr. C. G. V. Williams) has done the same. The following Members have been lost to the Society by death, viz., Professor H. M. Andrew, M.A., and Mr. Germain Nicholson, J.P.

Your Council, in revising the Members' list, has found cause for omitting the names of some persons who were defaulters

of long standing. The list now shows eighteen Life Members one hundred and seventeen Ordinary or Town Members, thirty-eight Country Members, seven Corresponding Members, twelve Honorary Members, and sixty-nine Associates. Total, two hundred and sixty-one.

Mr. A. H. S. Lucas resigned his seat on the Council in May last, on account of the pressure of other engagements, and his place was filled by the election of Mr. C. A. Topp, M.A., LL.B., F.L.S., on the 14th of June.

Mr. Barnard also resigned the office of Hon. Secretary, and was succeeded by Professor W. Baldwin Spencer, M.A., who was elected Hon. Secretary at the Ordinary Meeting in November.

Dr. J. J. Wild's period of engagement as Assistant Secretary having expired, it was considered advisable to appoint a person less engaged in other directions, and Mr. Loton Cattlin, the present Clerk and Sub-Librarian, was accordingly engaged, and by his exertions the Library has at last been made effectively accessible to Members, the catalogue having been completed by him so far as to show where, on the shelves, any volume is to be found. He will next undertake the compilation of an alphabetical index, under proper heads of subjects, and names of Societies. The Sub-Librarian, by present arrangement, attends on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, from 4 to 6 o'clock p.m., and is prepared to give information and assistance to Members desiring to consult the Library.

The Hon. Librarian reports that the following additions to the Library have been received during the year, the increase in number being apparently due to the greater regularity in acknowledging the receipt of publications:— From England 188 parts, Scotland 23, Ireland 11, Germany 109, Austria 16, Switzerland 2, France 7, Spain and Portugal 14, Italy 56, Holland and Belgium 35, Denmark, Sweden and Norway 10, Russia and Roumania 12, India and Mauritius 12, China and Japan 8, Canada 5, United States 87, Mexico 44, Argentine Republic 4, Australasia, Victoria 147, New South Wales 27, South Australia 2, Tasmania 3, Queensland 13, New Zealand 8. Total publications received, 843.

In connection with the Treasurer's Balance Sheet and Statement of Accounts which are appended, the Hon. Treasurer desires to impress upon the Members of the

Society that the financial position of the Society has only been maintained by the exercise of rigid economy, rendered imperative by the extra expenditure which has been undertaken, but as yet scarcely been actually commenced, in the Biological Survey of Port Phillip, and the proposed publication of the results in a more costly form. Not only have no bookbinding or repairs been executed, though much required, but the urgent want of increased shelving in the Library remains unsatisfied, and some considerable accounts remain unpaid, as appears in the statement of liabilities. On the other hand, the amount of subscriptions received has been abnormally augmented for the year by the collection of arrears. Although, therefore, the present balance to the credit of the Society compares favourably with the last, the future contemplated expenditure will be much greater, and to carry it into effect successfully, an increased income must be provided.

Dr. *The Hon. Treasurer in Account with the Royal Society of Victoria.* **Cr.**

To Balance on 1st March, 1888					£179	19	10	By Printing and Stationery	£272	1	5
„ Government Grant—								„ Expenses of Port Phillip Biological Survey ..	28	13	9
Balance of Vote for 1887-88	£50	0	0					„ Rates	5	10	0
„ „ 1888-89	50	0	0					„ Gas and Fuel	8	1	11
				100	0	0		„ Salary of Assistant Secretary	76	13	4
„ Entrance Fees				23	2	0		„ Shorthand Writer's Records	6	6	0
„ Subscriptions—								„ Hall-keeper's Allowance	8	14	0
Life Memberships	52	10	0					„ Collector's Commission	38	5	2
Ordinary Subscriptions, 1888	253	11	6					„ Insurance	3	10	0
„ „ 1889	10	10	0					„ Secretary's Postages	79	12	7
Arrears	61	19	0					„ Repairs	10	1	6
				378	10	6		„ Treasurer's Postages and Petty Cash	1	9	6
„ Rent of Rooms				25	11	0		„ Balance in Bank, 1st March, 1889	192	14	10
„ Sale of Transactions				0	12	6					
„ Interest				23	18	2					
				£731	14	0			£731	14	0

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Compared with the Vouchers and Bank Pass-book and Cash-book, and found correct,

J. JAMIESON,
Hon. Treasurer.

7*th March*, 1889.

(Signed) R. E. JOSEPH, H. MOORS, } Auditors.

PUBLISHING AND RESEARCH FUND.

Dr.		Cr.	
To Fixed Deposit in Bank	£300 0 0	By Fixed Deposit in Bank	£300 0 0
,, Interest	15 0 0	,, Interest transferred to General Account	15 0 0
	£315 0 0		£315 0 0

STATEMENT OF LIABILITES AND ASSETS.

Dr.			Cr.		
To Two Debentures		£10 0 0	By Outstanding Subscriptions (say)		£50 0 0
,, ,, ,, Interest unclaimed		8 8 0	,, Rents due		25 0 0
,, Estimated Outstanding Debts—			,, Hall, Library, and Furniture		5000 0 0
Printing Account	£65 0 0		,, Balance of Grant, 1888-9	£150 0 0	
Shorthand Writer's do.	12 0 0		,, Moiety ,, 1889-90	100 0 0	
Other small do.	3 0 0				250 0 0
		80 0 0	,, Publishing Fund	300 0 0	
,, Grant to Librarian		10 0 0	,, General Account Balance	192 14 10	
,, ,, P.P.B.S. Commitee		21 6 3			492 14 10
,, London Illustration Account		20 0 0			
,, Balance		5668 0 7			
		£5817 14 10			£5817 14 10

On the motion of Mr. ELLERY, seconded by Mr. BLACKETT, it was resolved that the Report and Balance Sheet be taken as read, and be adopted.

ELECTIONS.

The retiring Office-bearers and Members of Council were re-elected.

AMENDMENT OF RULES.

Mr. RUSDEN said it would be remembered that in December he gave notice of motion regarding certain amendments necessary in the laws, which were about to be re-printed.

The amendments proposed by Mr. Rusden were then considered, and adopted with one or two verbal alterations (see Rules pp. 171).

Mr. MACDONALD moved that the Rules as amended that evening be printed and adopted as the Rules of the Society.

Mr. ELLERY seconded this motion, which was carried.

On the motion of Mr. ELLERY, the Meeting resolved itself into an Ordinary Meeting.

ORDINARY MEETING.

The reading of the minutes was deferred till the next meeting.

Mr. WHITE moved the suspension of the standing orders, to enable the election of Mr. Cameron, of Orbost, to be proceeded with.

Mr. Cameron was then elected as a Member.

Mr. J. M. Coane signed the Register, and was introduced to the Meeting.

The following short addresses were then read:—

(1) "On Recent Progress in Astronomy," by Mr. R. L. J. Ellery, F.R.S., C.M.G.

(2) "On Recent Progress in Geology," by Mr. G. S. Griffiths, F.G.S.

(3) "On Hygiene," by Dr. Jamieson.

The Meeting then adjourned to Thursday, March 21.

Thursday, March 21st.

The President (Professor KERNOT) in the chair.

Short addresses were read :—

(1) "On Recent Progress in Mechanical Science," by Professor Kernot, M.A., C.E.

(2) "On Recent Progress in Literature and Fine Arts," by Dr. J. E. Neild.

(3) "On Recent Progress in Biology," by Mr. A. H. S. Lucas, M.A., B.Sc.

Thursday, April 11th.

The President (Professor KERNOT) in the chair.

The minutes of the Annual and last Ordinary Meeting and adjournment thereof, were read and confirmed.

The PRESIDENT announced that the Hon. Dr. Agnew, of Hobart, who was recently elected an Honorary Member of the Society was present that evening. He trusted that Dr. Agnew might frequently be able to attend the meetings of the Society, and expressed the hope that other scientific gentlemen from the adjoining colonies, would honour them occasionally with their presence.

Mr. Edward Davies was nominated as an Associate.

Dr. NEILD, the Hon. Librarian, announced that fifty-five publications had been received since last Meeting.

The Hon. Dr. J. W. Agnew, of Hobart (Honorary Member), and the Rev. A. W. Cresswell and Mr. Gabriel (Associates), were introduced, and signed the Book.

The following papers were read :—

(1) "On a New Species of Bicellaria," by J. Bracebridge Wilson, M.A.

(2) "On some New Species of Marine Mollusca," by J. Bracebridge Wilson, M.A.

(3) "The Crinoids obtained in the Port Phillip Biological Survey," by one of the Hon. Secretaries.

(4) "Systematic Census of Indigenous Fish, hitherto described, from Victorian Waters," by A. H. S. Lucas, M.A., B.Sc.

(5) "Additions to the Fish Fauna of Victoria," by A. H. S. Lucas, M.A., B.Sc.

(6) "On the Occurrence of Krausia lamarckiana at Williamstown," by A. H. S. Lucas, M.A., B.Sc.

(7) "The Old Red Sandstone Rocks and Fossils of the Mansfield District," by Mr. George Sweet.

Mr. STIRLING hoped that Mr. Sweet would carry on his researches to the eastward. To the south of the area described by Mr. Sweet, there was an outcrop of bluish or greyish lava, which was probably Upper Silurian.

Mr. G. S. GRIFFITHS said that, up to the present time, the Devonian Rocks which occupied the region about sixty miles southward of the locality of Mr. Sweet's discoveries, and also the region eastward, were considered to belong to the Upper Devonian, but no fossils with the exception of a few vegetable remains had been discovered there.

Mr. SWEET said he had not examined the rocks to the eastward, except some fifteen miles in that direction. The same plants that were found in the Iguana Creek beds were also found on the top of Hat Hill. The rocks he examined were in an almost continuous line with the coal beds in Gippsland. If Carboniferous rocks were to be found outside of the Gippsland District, the two localities mentioned in his paper would be the proper places to look for them.

Mr. GRIFFITHS said that the locality examined by Mr. Sweet was considered by Mr. Howitt as having at one time been part of an old sea loch. Nearer to the sea were to be found the remains of ancient volcanoes of vast dimensions. When those volcanoes were in their prime, the country stood at a greater elevation than now. It then sank, until the sea overspread portions of it. The volcanoes then sank and died out, and the mountain glens were transformed into sea lochs. The conglomerates filled up these lochs. There was then a re-elevation of the land, and tremendous denudation, and another period of subsidence. On the top of the conglomerates, beds of marl and limestone were formed, and it was those beds that had been examined by Mr. Sweet.

Mr. LUCAS said that since the discovery of the Muddy Creek beds, no series of fossils such as had been brought to light by Mr. Sweet, had been obtained in the colony. It would be desirable to know if, in Tasmania, fossil fish had

been obtained in the Carboniferous limestone. To his knowledge, no such fossils had been found in Tasmania.

Mr. SWEET said one point which might be considered of interest in that direction, was the presence of Lepidodendron plants in the upper beds. The land plants first found in the beds were very small, not larger than the thumb. The larger plants seemed to indicate that they had not travelled a great distance by water. Professor McCoy had not yet had time to examine the fish thoroughly, but his first impression appeared to be that they were marine forms.

Thursday, May 9th.

The President (Professor KERNOT) in the chair.

The minutes of the last Meeting were read and confirmed.

Mr. Guilfoyle was nominated as a Member, and Mr. Hubbart as an Associate.

Mr. R. Barton and Mr. Edward Davies were elected Members.

Dr. NEILD announced that forty-nine new publications had been added to the Library during the past month. It was in contemplation to have additional shelves placed in the Library.

The Vice-President (Mr. E. J. WHITE, F.R.A.S.) read a paper "On Barometric Measurement of Heights," in which he presented some new tables for the barometric measurement of heights, which was followed by a long discussion in which the President and Messrs. J. M. Coane and Field took part.

Thursday, June 13th.

The President (Professor KERNOT) in the chair.

The minutes of the previous Meeting were read and confirmed.

Mr. E. Davies was introduced by the President as an Associate of the Society.

Mr. Guilfoyle, Director of the Botanical Gardens was elected a Member, and Mr. J. R. Hubbart an Associate.

Mr. M'Alpine was nominated as a Member of the Society.

NEW SECTION.

The PRESIDENT said:—I wish to draw the attention of the Meeting to a circular signed by Mr. H. K. Rusden, one of the Hon. Secretaries of the Society, which has been

The chair having been vacated by the President in favour of the Vice-President, Mr. White.

Professor KERNOT read a paper on the "Barometric Measurement of Heights," giving the results of measurements taken on a recent trip.

Mr. ELLERY said that the subject of the Barometric Measurement of Height, was one in which all engineers and surveyors must be interested. So far as his experience went, a well made aneroid barometer was an extremely useful instrument. Those who claim for the aneroid barometer more perhaps than it deserves, must recollect that they have not an easy thing to measure in weighing the atmosphere. If people would only look at the weather chart sent out from the Observatory every day, they would come to the conclusion that this was true. Thus, in taking a line with the mercurial barometer from the Observatory to Gabo Island, it is found that in certain spots incorrect readings are obtained. There are certain spots where there is a depression in the atmosphere. Professor Kernot had told them that he took readings from his barometer while the train waited a few seconds at the different wayside stations. Such readings were invariably incorrect. It takes some time before the aneroid gets right after the motion of the train. It must be read, to get correct readings, some minutes after the train has stopped. Another thing, in the small barometers, ten feet were represented by a hundredth part of an inch, and as such, were not an easy thing to read. The greatest defect in these aneroids lay in the want of knowledge of the conditions of the atmosphere at the points of observation. But even at best, the results to be gained were merely approximate.

Mr. ALLEN said that so far as his experience went, the aneroid barometer was perfectly useless, except when the weather was favourable. He had recently made experiments with one of Watkin's best instruments, one of Mason's No. 1, and another of Watkin's No. 2. He tried to take the height of a mantelpiece from the floor. The first result was, that Mason's gave 13 feet; Watkin's No. 1, 7 feet; and Watkin's No. 2, 3 feet. He next raised the instrument, with the result that in Mason's there was no difference; Watkin's No. 1, no difference; Watkin's No. 2, 2 feet.

A long discussion ensued, in which Messrs. Coane, Allen, Campbell, White, Yates, and the President took part.

Professor SPENCER read a paper "On the Pineal Eye of *Mordacia mordax.*"

Professor KERNOT remarked that the pineal eye was one of the most curious things ever discovered by anatomists. The subject was an intensely interesting one. It would be interesting to know how human beings came to lose the pineal eye.

Mr. ELLERY read a paper written by Mr. G. W. Perry "On a New System of Photo-Lithography."

In reply to Mr. Ellery, Mr. PERRY said he could not speak just now as to the cost, but there was no doubt as to the rapidity of the process. A transfer could be taken in the morning, and prints secured in three or four hours. The stone had to mature for three or four hours.

Thursday, July 11th.

The President (Professor KERNOT) in the chair.

The minutes of the last Meeting were read and confirmed.

Mr. Vickery, Mr. Barton, and Mr. Love signed the Roll, and were introduced to the Meeting.

Mr. Ingamells and Miss Helen H. Neild were nominated as Members.

Regarding the nomination of Miss Helen H. Neild, the PRESIDENT said that the proposal of a lady as a Member of the Society, marked an era in its history. After careful search through the Laws, the Council could find nothing to prevent a lady becoming a Member of the Society. He believed the Society was formed on the supposition that ladies as well as gentlemen would become Members of it. The ladies had not hitherto come forward to claim their right, but it was not improbable that many others would follow the example set by Miss Helen H. Neild. The particular circumstance that led to the nomination under notice, was the establishment of Section G—Literature and Art. In that Section, ladies would probably take a particular interest.

Mr. D. M'Alpine was elected a Member of the Society.

Mr. ELLERY proposed, and Dr. NEILD seconded, the nomination of Mr. Howitt to fill the vacancy on the Council, caused by the resignation of Mr. Bage.

The motion was put, and carried unanimously.

SECTION G.

The PRESIDENT brought under the notice of Members a statement as to the formation of Section G—Literature and Art, including Architecture. A circular was issued on the 5th of last month, requesting gentlemen interested in the matter to attend a preliminary meeting. That meeting was held in the Lower Hall on the 20th of last month, and the Section was duly formed. Although the formation of Section G was a new departure in the history of the Society, yet it was one that had been contemplated by the founders of the Society, and provided for under the Laws. Until Dr. Neild in his excellent address at the beginning of the year had called attention to the matter, no one had taken it up. He hoped that the formation of the Section would add to the success of the Society. The Inaugural Meeting would take place on the 23rd of August.

Dr. NEILD thanked the Members for the cordial way in which they had received the report of the Meeting. Nothing could be more cordial, nor more friendly, than the manner in which the proposition had been received by the Council. Outside the Society, the starting of Section G had occasioned a great deal of satisfaction. Mr. Way, who was elected Chairman of the Section, and who was very proud of the honour allotted to him, had asked him to express his regret at not being able to attend that evening, and to express his thanks for the honour done him.

Dr. NEILD, the Hon. Librarian, reported that since last meeting sixty-six new publications had been added to the Library. Thanks were due to Mr. Cattlin, who had worked hard to get it in order.

Mr. DENDY read a paper on "The Australian Species of Peripatus."

After some remarks from Professor SPENCER, the latter read a paper on "The Anatomy of Amphiptyches urna."

Mr. LUCAS said that as the fish, *Callorhynchus antarcticus* in which the parasite lived, was carnivorous, it seemed not

unlikely that the parasite would take a different form in one of the herrings on which the fish lived.

Dr. RALPH said that in the bladder of a frog would at times be found a very beautiful Distome. It was twenty years ago since he first saw it. It was above a quarter of an inch in length, and beautifully transparent. The ova could be seen through the integuments, and also the embryos struggling in the body of the parasite.

Mr. DENDY said that in the University laboratory they had found very few specimens of the Distome in the frog. It was remarkable that in the Australian frog, the worm had only two suckers, while the English one had five.

Mr. FENTON read a paper on "The Calculimetre."

A long discussion ensued, in which the President and Messrs. White, Love, and Marks took part.

Thursday, August 8th.

The President (Professor KERNOT) in the chair.

The minutes of the preceding Meeting were read and confirmed.

Mr. Frank Cole was nominated as a Member; Rev. Lorimer Fison, Rev. Dr. Bevan, Mr. Maloney, and Mr. W. W. Harris as Associates.

The PRESIDENT stated that the first business meeting of Section G would take place on Friday, the 23rd instant.

Dr. NEILD then read the Library report, which showed that sixty-two publications had been added to the Library during the past month.

The PRESIDENT called the attention of Members to a paper which had reached them that evening, from the Hon. Dr. Agnew. The paper had been read before the Australasian Association in Sydney last year. The subject was "The last of the Tasmanians." The last of the Tasmanians was an old lady, Truganini. Her husband who, he thought, had departed this life before her, was known as King Billy. Accompanying the paper was a large photograph of the latter. He thought the information contained in the paper was of great value and interest, as bearing upon the last survivors of the race.

The PRESIDENT then read a letter which had been received from the Secretary of the Victorian Engineers' Association, on the proposed amalgamation of scientific societies. He said that this matter had been considered by the Council of the Society. Of course this Society was in a different position to many other scientific bodies. They had an excellent building of their own, and did not feel the necessity for a local habitation as some of the other societies did; but at the same time, the Council had not entirely refused to look into the matter, and a committee had been appointed to meet with the gentlemen interested, to hear what they had to say. A question that had been agitated from time to time was, whether the meeting house of the Society was a suitable one as to position, or whether a better one could be found. As the property was valuable, it might be made to provide funds to enable them to have apartments or accommodation in some more central position. However, the matter at present was merely a suggestion, and he was not in a position to express any opinion. A number of societies besides those mentioned in the letter had been discussing the matter for some time past. He thought it right to give the members of the Society this information, but he thought the Royal Society would be about the last of the societies to feel a strong pressure in the direction of joining in the movement. Still, it might be to their interest to join it, for the purpose of securing quarters in a more central position. He believed that, were the place of their meetings within three minutes' walk of Flinders Street station, they would be more largely attended. If anything further were done in the matter, the Members would be notified.

Mr. DENDY read a paper "On the Anatomy and Histology of an Australian Land Planarium," which he illustrated by means of charts and sketches on the blackboard.

A discussion ensued, in which the President, Professor Spencer, Mr. Lloyd Marks, and Mr. Griffiths took part.

Mr. RUSDEN read a paper communicated by Mr. J. H. Maiden, F.L.S., F.C.S., Curator of the Technological Museum, Sydney, on "Liquid Kino."

Dr. NEILD said that Kino had been employed many years ago very largely for many purposes where astringents were required, but of late years it had not been used. He would suggest that a quantity of Kino should be subjected to some test, and that some should be tried in the hospitals.

In the ensuing discussion, the President, Mr. Lloyd Marks, and Mr. Howitt took part.

Thursday, September 12th.

The President (Professor KERNOT) in the chair.

The minutes of the preceding Meeting were read and confirmed.

Mr. D. M'Alpine signed the book, and was introduced to the Meeting.

Mr. A. G. Melville, Rev. E. H. Sugden, Rev. W. Allen, Mr. Fred. Tate, B.A.; Mr. T. A. Sisley, Rev. John Reid, Professor Morris, and Mr. Vidler were proposed as Members.

Mr. F. N. Ingamells, Mr. F. H. Cole, M.B.; Rev. Dr. Bevan, Miss Helen H. Neild, Dr. W. Maloney, Rev. L. Fison, and Mr. W. W. Harris were elected Members of the Society.

Dr. NEILD, the Hon. Librarian, reported that eighty volumes had been added to the Library since last Meeting, and that the improvements for the accommodation for additional books were being completed.

Mr. H. K. RUSDEN read a report by Mr. A. S. Way, President of Section G, of the progress of that Section.

The PRESIDENT congratulated the Members on the success of the Section, which bade fair to become the most popular of all.

The PRESIDENT exhibited and explained the action of a set of Kinematic Models, belonging to the Engineering Class of the University.

BARON VON MUELLER read a paper on "Records of Observations on Sir William MacGregor's Highland Plants from New Guinea," and exhibited the plants which had been forwarded to him from New Guinea by Sir Wm. MacGregor. He said that Sir Wm. Macgregor, to his infinite credit, in addition to performing his official duties, had, as a man of Science, worked hard in New Guinea. It was not necessary to enter into details of His Excellency's exploits, inasmuch as the Queensland papers had noticed them rather fully, and an excellent *resumé* of his work had been published. The tour of discovery undertaken by His Excellency, had been one in which extraordinary difficulties had to be encountered. Great efforts had to be made, and ingenuity

exercised, in obtaining the specimens from the abrupt crest in which the Owen Stanley Range terminated. As that Range rose to the height of 13,000 feet, there was at its summit a thousand feet of Alpine country. Still higher mountains covered perpetually with snow, had come into view. There was in New Guinea what was called a highland vegetation—Sir Wm. MacGregor termed it a Sub-Alpine vegetation. It was at the commencement of a new line of research, which he hoped Australia would carry out. A series of years would have to be occupied before the whole of the ranges, which were Alpine, could be exhaustively explored. This was owing partly to the difficulty of approaching them in their present state. The presence of the natives and the extraordinary abruptness of the ranges were the difficulties. It would require a man of great energy and strength to overcome those difficulties, and His Excellency the Governor of British New Guinea had done good work in that direction. A number of the plants obtained were to be found not only in the Snowy Mountains in Victoria, but down to the Auckland Islands. The same held good in regard to the Himalayas. There was therefore an intermixture of the forms peculiar to the Himalayas and the far South. Sir William MacGregor had discovered that some of the plants found on a mountain in North Borneo, also 13,000 feet high, were to be found also in New Guinea.

A discussion ensued, in which the President, Mr. Stirling, Dr. Wigg, Mr. G. S. Griffiths, and Baron von Mueller took part.

Thursday, October 10th.

The President (Professor KERNOT) in the chair.

The minutes of the last Meeting were read and confirmed.

Miss H. H. Neild signed the book, and was introduced to the Meeting.

Dr. NEILD said:—Mr. President and Gentlemen, I thank you for having elected my daughter as an Associate of this Society. She is the first lady Member, and her election marks an era in the existence of the Society, which has now been established for thirty-six years. I have heard some expressions of misgiving as to the propriety or expediency of

introducing the female element into this Society. There is a fear that it might destroy its severely scientific character. I do not think the principal Members share those misgivings. In the present day, women are coming to the front in every direction, and I do not see why they should not, so long as they do not go to the extreme lengths recommended by the Women's Rights Association. So far as the intellectual position of women is concerned, I do not see why she should not take her position with us. I think we should welcome the advent of ladies into the Society, and I do not think any misfortune is likely to happen as the result, as we all know the particular reason of this influx is on account of the development of Section G—Literature and Art. I believe most of the ladies who intend to become Associates are attracted by that Section. As Mr. Way will inform you, we have had in our Shakespeare Society some most gratifying evidence of the advantage of including women among our members. We have had several ladies who have read very good papers, and they have from time to time taken part in the discussions. I am sure the effect of their presence at our meetings has been of a beneficial kind. I thank you very much for the honour you have done my daughter.

The PRESIDENT said the Council, at any rate, felt no misgivings as to the propriety of admitting ladies to the Society. This was evidenced by the fact that they all signed Miss Neild's nomination paper. It was hardly large enough to contain the names of the members of the Council. I certainly agree with Dr. Neild that there is not the slightest reason why ladies should not be most useful members of the Society, not only of the literary, but of the scientific sections.

The PRESIDENT submitted a long list of names of ladies and gentlemen nominated for membership.

Dr. NEILD, the Hon. Librarian, reported that fifty-four new volumes had been added to the Library since the last meeting.

Mr. WAY said :—I am not prepared with a written report showing the progress of Section G. That is in the hands of the Secretary. But I can report in a general way that our second meeting was even more successful than the first. At our first meeting we had about fifty members present, but at our second meeting we had seventy. I am told that a large number came to the door, and seeing the crowded state of the room, went away in despair. The meeting, as far as I could judge from the expressions of those who were present,

seems to have been very successful, in the sense of being interesting and instructive, as well as inspiring. The subjects taken up had evidently in many persons created quite a new interest. While our first meeting was confined rather to the consideration of Literature, the second meeting was confined almost entirely to Art. This is gratifying evidence of how rapidly we are taking up the subjects which we intend Section G should embrace. Owing to Dr. Wigg being disappointed by a friend who should have provided him with certain materials, he preferred to hold over his paper, and an address was delivered by Mr. Archer, who spoke from a very full mind on Ruskin and Turner. It was a very interesting discourse, and evidently awakened new interest and enthusiasm in the minds of those present. The address was illustrated by a large number of Turner's drawings and sketches, and the interest was so well kept up that the meeting did not break up till half-past ten or thereabouts. I think we have every reason to congratulate ourselves on the progress made. We have no dearth of papers, as we have three or four standing over from last meeting, so I think the Society may look forward to a career of considerable prosperity and usefulness in this, its youngest Section.

Mr. E. F. J. LOVE read a paper "On a Proposed Gravity Survey of Australia."

The PRESIDENT said that we certainly seemed to be in a favourable position for making such observations, and if the work could be done in a satisfactory manner for anything like the sum of money named by Mr. Love, there would not be much difficulty in providing it. If the work were done in the way proposed, a substantial and valuable addition to our knowledge on this subject would be gained. Certainly, if it could be done at anything like the cost suggested by Mr. Love, then nothing should be allowed to hinder its being done.

Mr. ELLERY said there was no doubt that the matter was of great scientific importance. Pendulums had been swung in Melbourne and some other places, but he thought the best work was done by Professor Neumeyer, who reported to this Society some years ago. He had recently heard from him as to the final results, which were for a long time in considerable doubt. The use of the pendulum leaves a considerable margin of doubt, and if an undertaking of this kind were to be made now, he would suggest that a very careful investigation

should be made into the results of pendulums now in existence. At the last transit of Venus, a party of scientific observers under Professor Harkness, brought out with them their pendulums. They were swung here, and had been swung before in several places along the Pacific line, but he had never seen any results published of those observations. He did not think it would be necessary in many places, at all events, to take any trouble about the geographical position or actual time. Nearly all the points could be got at the established Observatories, so that it would be hardly necessary for the observer to burden himself with transit instruments or anything of that kind. He thought one or two pendulums could be obtained from Kew on loan. We could get the pendulum that Professor Neumeyer used from the Hamburg Observatory. It follows, therefore, that the expense of the undertaking would not exceed the actual expense of the observer and his assistants. If once an observer has become *au fait* in his observations, they can be done very rapidly. The work done by Professor Neumeyer occupied only two hours. American observers did it in two hours. The supports of the pendulum are made so nicely now, that they have only to be set to be swung.

Mr. WHITE thought this a matter of great importance. Strange to say, attention was drawn to this matter in the early days of the colony. The first arrangement of pendulums was made here by the Spaniards, then in Port Jackson by the French Expedition in 1819. The results were not very successful. It was done in Parramatta again in 1827, more satisfactorily. The only measurements in Melbourne that he knew of were those of Professor Neumeyer and Captain Harkness. He had seen Captain Harkness four or five years ago, and he mentioned that the results were not such as to please him, and he had not published them. He thought the personal expense would be much larger than Mr. Love anticipated, although the apparatus could be obtained; and he had no doubt the resources of the Observatory would be at his disposal, and that if the matter were brought before the different Governments, Victoria at all events would lend assistance. He would like to have more observations made upon the main land of Australia, than at the coast.

Professor LYLE said that this was a subject that had interested all scientific men, from Newton's time downward. They had worked at the probability of the shape of the earth.

He thought it would be a very proper thing for the Society to try and get some kind of expedition formed to make observations, and see if they would correspond with the results obtained by Newton. Mr. Love suggested the possibility of the earth not being spheroid, but ellipsoid. He doubted very much if the gravity determination would tell us that. About practical details, he thought the expense should not exceed £300, and that sum should not interfere with the carrying out of the project.

Mr. ELLERY said that, having had some considerable experience in former times in obtaining the sympathy of our neighbouring colonists in matters of this kind, he thought we should now set to work to make some little enquiry into the matter. When it was desired to carry out the telegraphic determination of longitude, we adopted a similar course. The neighbouring colonies contributed their quota, and there was no trouble so long as the Government were satisfied that it was scientific work endorsed by scientific people. If the Society made up its mind upon the matter, we could communicate with the Home authorities as to the possibility of getting reliable pendulums. So soon as we considered the thing practical and desirable, we could apply to the Premier of the colony for the necessary assistance, and also ask the neighbouring colonies to join in the expense.

The PRESIDENT said:—As to the expense, he could corroborate what Mr. Ellery has said. He thought that there would be no real difficulty in getting the comparatively small sum of money required for such a survey, provided we could show that it was a real scientific work; and secondly, that what we propose, to do was not likely to end in a fiasco. Of course no Premier or Treasurer liked to give some hundreds of pounds and then afterwards find nothing done, but provided there were reasonable prospects of observations being made, with proper instruments and a sufficient amount of skill to ensure that the results would be reasonably accurate and comparable with results elsewhere, they would not be against such a proposal.

Mr. ELLERY undertook to write to England to learn what pendulums could be obtained.

The PRESIDENT said that he regretted to have to make the announcement to the Members of the death, since the

last meeting, of two gentlemen who had been prominent figures in times past in connection with Science in Australia. The Rev. Tenison Woods was well known for his Geological investigations. He was a corresponding Member of this Society, and his name was known in all scientific circles throughout Australia. The other name he would mention was that of Mr. R. Brough Smyth, who was Secretary to the Philosophical Society of Victoria. His name appeared as Secretary in the earliest volume. It would therefore appear that he was one of its founders. After a few years, that Society changed its name to that of the Philosophical Institute, and then became merged into the Royal Society of Victoria. Mr. Smyth published a large number of Geological maps, and also a very large and complete book on the Aborigines of Victoria, of which we had a copy in this Library. Mr. Smyth recently occupied the position of Director of the School of Mines at Sandhurst. He died at the comparatively early age of 59.

Mr. E. J. White F.R.A.S., read a paper "On Results of Longitude from Lunar Observations."

Mr. ELLERY said that, if lunar observations were more frequently made, the loss of ships would not be so great. There had not been so great an advance in the manufacture of sextants as of chronometers, but the sextant was the most valuable stand by.

The PRESIDENT said it was matter for regret that the Society could not do something to remedy the state of affairs on ships described by Mr. Ellery. If a lunar observation required even so much as ten hours solid work, it would certainly, in view of the life and property that was risked, be advisable to have it done on shipboard.

Mr. WHITE said that ten minutes' time was all that was necessary for the purpose of taking the observation. There was no power granted to any one to condemn a bad chronometer, and Mr. Ellery could not do such a thing were he asked to test one at the Observatory. He had no power to compel the ship captain to get a new one; in fact, the captain could go to sea without a sextant or chronometer.

The Rev. J. J. HALLEY suggested that the Government might be approached on the matter, so that provision might be made to compel captains to have proper instruments on going to sea.

Mr. ELLERY said that the only manner in which attention could be called to the matter in the right quarter, would be by addressing the Marine Board here, and the Board of Trade in Great Britain. He did not think that at present it was desirable to take any step in the matter. The difficulty experienced in compelling ship owners to carry life saving appliances on ships, showed how hard it was to bring pressure to bear.

Thursday, November 14th.

The President (Professor Kernot) in the chair.

The minutes of the Meeting of October 10 were read and confirmed.

Mr. Ingamells as an Associate, and Mr. Wooster as a Country Member, were introduced to the Meeting by the President, and signed the roll.

Mrs. Riddell, Mr. J. Steele Robertson, Mr. J. Ross, Mr. L. Slade, and Mr. T. Fink, were nominated for election.

A large number of ladies and gentlemen were elected as Members or Associates, the President remarking that he did not remember having seen so long a list of names proposed for election. Most of those just elected were coming forward in connection with the new section—Literature and Fine Arts.

The Librarian's report showed the addition of eighty parts or numbers to the Library in the preceding month.

RE-ELECTION OF COMMITTEES.

The Members of the Port Phillip Biological Survey Committee were re-elected on the motion of Mr. Lucas, with power to add to their numbers.

The Members of the House Committee, on the motion of Mr. White, were re-elected.

The Members of the Royal Society on the Antarctic Committee, on the motion of Mr. White, were re-elected to act on that Committee.

The PRESIDENT said that the House Committee had very little to report. Improvements in the way of new bookcases

had been made to the building, and it would be necessary to re-appoint the Members of the Committee, so that if any small matter connected with the building required attention, it could be dealt with.

Mr. H. K. RUSDEN said that he was sorry to say that no great activity had been necessary on the part of the Antarctic Committee. A communication had been received from Norway, in reference to the proposal by Mr. Gunderson to send two ships to this side of the world. Information was required as to the particular kind of whale that inhabited the Southern Ocean. The authorities were not very precise on the point. When Ross went South in 1841–2, he saw a great number of whales, but very few of the people on board the ship knew anything of the different kinds. They observed a difference of some kind. A few years ago Mr. Musgrave, of Cape Otway, gave some information, but on the whole not enough of it was obtained to warrant a communication being sent to Mr. Gunderson. When a reply was received from the Marine Department in New Zealand, he would be communicated with.

The PRESIDENT read the report of the progress of Section G.

Mr. LUCAS, in the absence of Dr. McGillivray, gave a summary of the contents of Dr. McGillivray's paper "On Description of New or Little-known Polyzoa, Part XIII." He said that eleven new species had been discovered, and the paper was accompanied by two plates illustrating nine of them. As usual, Mr. Bracebridge Wilson's name appeared as the actual discoverer of the new species.

Mr. DENDY read a paper "On the Pseudo-Gastrula stage in the Development of Calcareous Sponges."

A discussion ensued, in which the President and Messrs. Wilson and Lucas took part.

Mr. MCALPINE read a paper "On the Transverse Section of Petioles of Eucalypts as Aids in the Determination of Species," by himself and Mr. Joseph Remfry.

Mr. LUCAS said that specialists had been enabled to judge of the species very largely by the anatomy of the plant. In many cases, the sections of the leaves were relied on. In the future, we should not have our floras described by the external forms only, but by the anatomy as well.

Thursday, December 12th.

The President (Professor KERNOT) in the chair.

The minutes of the last meeting were read and confirmed.

The Rev. Lorimer Fison and Mr. Thomas Currie (Associate) were introduced by the President to the Meeting, and signed the Roll.

The PRESIDENT announced that nominations should be made before the 1st of March next for the offices of President, Vice-President, Treasurer, Librarian, Honorary Secretaries, and six Members of Council.

The following were elected as Associates :—Mrs. Riddell, Mr. John Steele Robertson, Dr. Joseph Ross, Mr. Leonard Slade ; as Member, Mr. Theodore Fink.

Dr. NEILD, the Honorary Librarian, announced that ninety-two publications had been received during the past month.

The PRESIDENT stated that the Government had most generously increased to a very substantial extent the annual endowment to the Society, and in consequence, the Transactions would in future be prepared in an elaborate and better style than in the past. The new volume would be considerably larger than any published hitherto, and it would be issued during the ensuing month of January.

Mr. A. W. HOWITT, F.G.S., read a paper on "The Organisation of Australian Tribes."

The Rev. L. FISON said that Mr. Howitt's paper was specially important, because it showed that the aborigines of Australia—the lowest order of savages—were not only organised, but had a code of morals which was strictly observed, breaches of it rendering the person committing them liable to severe punishment. The system of group relationship, which Mr. Howitt had explained, had been found to exist not only amongst the aboriginals of Australia, but amongst the Iroquois Indians, and afterwards amongst the tribes of India. He had himself discovered its existence amongst the natives of the South Sea Islands. There were certain occasions, however, notably in Fiji, when epidemics were rife, on which certain tribes recurred to promiscuity as a means of propitiating the gods.

Mr. HOWITT, in reply to Mr. Dendy, said that promiscuity in the cases of certain Australian tribes did not appear to have

a deteriorating effect. In those tribes, he had seen men six feet high, as fine as any men he had seen in any other tribe, but the women were inferior.

Mr. SYDNEY GIBBONS, F.C.S., read a paper on "The Illumination of Public Clocks."

This was followed by a long discussion, in which Messrs. Ellery, M'Lean, White, Coane, and Marks took part.

On the motion of Mr. Archer, it was resolved that the two biological papers on the notice paper be taken as read, viz.:

(*a*) "On the Occurrence of a Partially Double Chick Embryo," by Mr. A. H. S. Lucas.

(*b*) "On the Formation of Twins in the Hen's Egg," by Professor W. Baldwin Spencer.

LAWS.

Amended and ordered to be Reprinted 14th March, 1889.

I. The Society shall be called "The Royal Society of Victoria." Name

II. The Royal Society of Victoria is founded for the advancement of science, literature and art, with especial reference to the development of the resources of the country. Objects.

III. The Society shall consist of Ordinary Members residing within ten miles of Melbourne; Country Members residing beyond that distance; Life Members (Law XXV), Honorary Members (Law XXIV), Corresponding Members (Law LIX), and Associates (Laws XXV, XXVI, and LX), all of whom shall be elected by ballot. Members and Associates.

IV. His Excellency the Governor of Victoria, for the time being, shall be invited to accept the office of Patron of the Society. Patron.

V. There shall be a President, and two Vice-Presidents, who, with twelve other Members, and the following Honorary Officers, viz., Treasurer, Librarian, and two Secretaries of the Society, shall constitute the Council. Officers.

VI. The Council shall have the management of the affairs of the Society. Management.

VII. The Ordinary Meetings of the Society shall be held once in every month during the Session, from March to December inclusive, on days fixed and subject to alteration by the Council with due notice. Ordinary Meetings.

VIII. In the second week in March, there shall be an Annual General Meeting, to receive the report of the Council, and elect the Officers of the Society for the ensuing year. Annual General Meetings.

IX. All Office-bearers and Members of Council except the six junior or last elected Members, shall retire from office at the Annual General Meeting in Retirement of Officers.

March. Should a senior Member's seat become vacant in the course of the year, it shall be held by his successor (under Law XIII) as a senior Member, who shall retire at the next Annual General Meeting. The names of such Retiring Officers are to be announced at the Ordinary Meeting in December. The Officers and Members of Council so retiring shall be eligible for the same or any other office then vacant.

Election of Officers.

X. The President, Vice-Presidents, Treasurer, Secretaries, and Librarian shall be separately elected by ballot (should such be demanded), in the above-named order, and the six vacancies in the Council shall then be filled up together by ballot at the General Meeting in March. Those members only shall be eligible for any office who have been proposed and seconded at the Ordinary Meeting in December, or by letter addressed to one of the Secretaries, and received by him before the 1st March, to be laid before the Council Meeting next before the Annual Meeting in March. The nomination to any one office shall be held a nomination to any office, the election to which is to be subsequently held. No ballot shall take place at any meeting unless ten members be present.

Votes required.

Members in Arrear.

XI. No Member, whose subscription is in arrear, shall take part in the election of Officers or other business of the meeting.

Address by the President.

XII. An address shall be delivered by the President of the Society at either a Dinner, Conversazione, or extra meeting of the Society, as the Council may determine in each year.

Vacancies.

XIII. If any vacancy occur among the Officers, notice thereof shall be inserted in the summons for the next meeting of the Society, and the vacancy shall be then filled up by ballot.

Duties of President.

XIV. The President shall take the chair at all meetings of the Society and of the Council, and shall regulate and keep order in all their proceedings; he shall state questions and propositions to the meeting, and report the result of ballots, and carry into effect the regulations of the Society. In the absence of the President, the chair shall be taken by one of the Vice-Presidents, Treasurer, or Ordinary Member of Council, in order of seniority.

XV. The Treasurer may, immediately after his election, appoint a Collector (to act during pleasure), subject to the approval of the Council at its next meeting. The duty of the Collector shall be to issue the Treasurer's notices, and collect subscriptions. The Treasurer shall receive all moneys paid to the Society, and shall deposit the same before the end of each month in the bank approved by the Council, to the credit of an account opened in the name of the Royal Society of Victoria. The Treasurer shall make all payments ordered by the Council on receiving a written authority from the chairman of the meeting. All cheques shall be signed by himself, and countersigned by one of the Secretaries. No payments shall be made except by cheque, and on the authority of the Council. He shall keep a detailed account of all receipts and expenditure, present a report of the same at each Council meeting, and prepare a balance-sheet to be laid before the Council, and included in its Annual Report. He shall also produce his books whenever called upon to do so by the Council. Duties of Treasurer.

XVI. The Secretaries shall share their duties as they may find most convenient. One or other of them shall conduct the correspondence of the Society and of the Council, attend all meetings of the Society and of the Council, take minutes of their proceedings, and enter them in the proper books. He shall inscribe the names and addresses of all Members and Associates in a book to be kept for that purpose, from which no name shall be erased except by order of the Council. He shall issue notices of all meetings of the Society and of the Council, and shall have the custody of all papers of the Society, and, under the direction of the Council, superintend the printing of the Transactions of the Society. Duties of Secretaries.

XVII. The Council shall meet on any day within one week before every Ordinary Meeting of the Society. Notice of such meeting shall be sent to every Member at least two days previously. No business shall be transacted at any meeting of the Council unless five Members be present. Any Member of Council absenting himself from three consecutive meetings of Council, without satisfactory explanation in writing, shall be Meetings of Council. Quorum

considered to have vacated his office, and the election of a Member to fill his place shall be proceeded with at the next Ordinary Meeting of Members, in accordance with Law XIII.

Special Meetings of Council.

XVIII. One of the Secretaries shall call a Special Meeting of Council on the authority of the President or of three members of the Council. The notice of such meeting shall specify the object for which it is called, and no other business shall be entertained.

Special General Meetings.

XIX. The Council shall call a Special Meeting of the Society, on receiving a requisition in writing signed by twenty-four members of the Society, specifying the purpose for which the meeting is required, or upon a resolution of its own. No other business shall be entertained at such Meeting. Notice of such meeting, and the purpose for which it is summoned, shall be sent to every Member at least ten days before the meeting.

Annual Report.

Auditors.

XX. The Council shall annually prepare a Report of the Proceedings of the Society during the past year, embodying the Balance-sheet, duly audited by two Auditors, to be appointed for the year at the Ordinary Meeting in December, exhibiting a statement of the present position of the Society. This Report shall be laid before the Society at the Annual Meeting in March. No paper shall be read at that meeting.

Expulsion of Members.

XXI. If it shall come to the knowledge of the Council that the conduct of an Officer, a Member, or an Associate is injurious to the interest of the Society, and if two-thirds of the Council present shall be satisfied, after opportunity of defence has been afforded to him, that such is the case, it may call upon him to resign, and shall have the power to expel him from the Society, or remove him from any office therein at its discretion. In every case, all proceedings shall be entered upon the minutes.

Election of Members and Associates.

XXII. Every candidate for election as Member or as Associate shall be proposed and seconded by Members of the Society. The name, the address, and the occupation of every candidate, with the names of his proposer and of his seconder, shall be communicated in writing to one of the Secretaries, and shall be read at a meeting of Council, and also at the following meeting

of the Society, and the ballot shall take place at the next following Ordinary Meeting of the Society. The assent of at least five-sixths of the number voting shall be requisite for the admission of a candidate. Votes required to exclude.

XXIII. Every new Member or Associate shall receive due notice of his election, and be supplied with a copy of the obligation*, together with a copy of the Laws of the Society. He shall not be entitled to enjoy any privilege of the Society, nor shall his name be printed in the List of Members until he shall have paid his admission fee and first annual subscription, and have returned to the Secretaries the obligation signed by himself. He shall, at the first meeting of the Society at which he is present, sign a duplicate of the obligation in the Book of the Laws of the Society, after which he shall be introduced to the Society by the Chairman. No Member or Associate shall be at liberty to withdraw from the Society without previously giving notice in writing to one of the Secretaries of his intention to withdraw, and returning all books or other property of the Society in his possession. Members and Associates will be considered liable for the payment of all subscriptions due from them up to the date at which they give written notice of their intention to withdraw from the Society. Members shall sign laws. Conditions of Resignation.

XXIV. Gentlemen not resident in Victoria, who are distinguished for their attainments in science, literature, or art, may be proposed for election as Honorary Members, on the recommendation of an absolute majority of the Council. The election shall be conducted in the same manner as that of Ordinary Members, but nine-tenths of the votes must be in favour of the candidate. Honorary Members.

XXV. Ordinary Members of the Society shall pay two guineas annually, Country Members and Associates shall pay one guinea annually. Those elected after the Subscriptions.

* The obligation referred to is as follows:—

ROYAL SOCIETY OF VICTORIA.

I, the undersigned, do hereby engage that I will endeavour to promote the interests and welfare of the Royal Society of Victoria, and to observe its laws, as long as I shall remain a Member or Associate thereof.

(Signed)

Address

Date

Life Membership.

first of July shall pay only half of the subscription for the current year. Ordinary Members may compound for all annual subscriptions of the current and future years by paying £21; and Country Members may compound in like manner by paying £10 10s. Any Country Member having compounded for his subscription, and coming to reside within ten miles of Melbourne, must pay either the balance £10 10s. of the Ordinary Member's composition, or one guinea annually while he resides within ten miles of Melbourne. The subscriptions shall be due on the 1st of January in every year. At the commencement of each year there shall be hung up in the Hall of the Society a list of all Members and Associates, upon which the payment of their subscription as made shall be entered. During July, notice shall be sent to all Members and Associates still in arrears. At the end of each year, a list of those who have not paid their subscriptions shall be prepared, to be considered and dealt with by the Council.

Entrance fees, &c.

XXVI. Newly-elected Ordinary and Country Members shall pay an entrance fee of two guineas, in addition to the subscription for the current year. Honorary Members, Corresponding Members and Associates shall not be required to pay any entrance fee. If the entrance fee and subscription be not paid within one month of the notification of election, a second notice shall be sent, and if payment be not made within one month from the second notice, the election shall be void. Associates, on seeking election as Ordinary or Country Members, shall comply with all the forms prescribed for the election of Members, and shall pay the entrance fee prescribed above of Ordinary or Country Members respectively.

Duration of Meetings.

XXVII. At the Ordinary Meetings of the Society the chair shall be taken punctually at eight o'clock, and no new business shall be taken after ten o'clock.

Order and mode of conducting the business.

XXVIII. At the Ordinary Meetings business shall be transacted in the following order, unless it be specially decided otherwise by the Chairman :—

Minutes of the preceding meeting to be read, amended if incorrect, and confirmed.

New Members and Associates to enroll their names, and be introduced.

Ballot for the election of new Members or Associates.

Vacancies among officers, if any, to be filled up.

Business arising out of the minutes.

Communications from the Council.

Presents to be laid on the table, and acknowledged.

Motions, of which notice has been given, to be considered.

Notice of motion for the next meeting to be given in and read by one of the Secretaries.

Papers to be read.

Strangers.

XXIX. No stranger shall speak at a meeting of the Society unless specially invited to do so by the Chairman.

Papers to be first laid before Council.

XXX. Every paper before being read at any meeting must be submitted to the Council.

Additional Meetings.

XXXI. The Council may call additional meetings whenever it may deem it necessary to do so.

Visitors.

XXXII. Every Member may introduce two visitors to the meetings of the Society by orders signed by himself.

Members may read papers.

XXXIII. Members and Associates shall have the privilege of reading before the Society accounts of experiments, observations, and researches conducted by themselves, or original papers, on subjects within the scope of the Society, or descriptions of recent discoveries, or inventions of general scientific interest. No vote of thanks to any Member or Associate for his paper shall be proposed.

Or depute other Members.

XXXIV. If a Member or Associate be unable to attend for the purpose of reading his paper, he may delegate to any Member of the Society the reading thereof, and his right of reply.

Members must give notice of their papers.

XXXV. Any Member or Associate desirous of reading a paper, shall give in writing to one of the Secretaries, ten days before the meeting at which he desires it to be read, its title and the time its reading will occupy.

Papers by Strangers.

XXXVI. The Council may for any special reason permit a paper such as is described in Law XXXIII, not written by a member of the Society, to be read by one of the Secretaries or other Members.

Papers belong to the Society.

XXXVII. Every paper read before the Society shall be the property thereof, and immediately after it has been read shall be delivered to one of the Secretaries, and shall remain in his custody.

Papers must be original.

XXXVIII. No paper shall be read before the Society or published in the Transactions unless approved by the Council, and unless it consist mainly of original matter as regards the facts or the theories enunciated.

Council may refer papers to Members.

XXXIX. The Council may refer any paper to any Member or Members of the Society, to report upon the desirability of printing it.

Rejected papers to be returned.

XL. Should the Council decide not to publish a paper, it shall be at once returned to the author.

Members may have copies of their papers.

XLI. The author of any paper which the Council has decided to publish in the Transactions may have fifty copies of his paper on giving notice of his wish in writing to one of the Secretaries, and any further number on paying the extra cost thereof.

Members and Associates to have Transactions.

XLII. Every Member and Associate whose subscription is not in arrear, and every Honorary and Corresponding Member is entitled to receive one copy of the Transactions of the Society as published. Newly-elected Members shall, on payment of their entrance-fee and subscription, receive a copy of the volume of the Transactions last published.

Property.

XLIII. Every book, pamphlet, model, plan, drawing, specimen, preparation, or collection presented to or purchased by the Society, shall be kept in the house of the Society.

Library.

XLIV. The Library shall be open to Members and Associates of the Society, and the public, at such times and under such regulations as the Council may deem fit.

Legal ownership of Property.

XLV. The legal ownership of the property of the Society is vested in the President, the Vice-Presidents, and the Treasurer for the time being, in trust for the use of the Society; but the Council shall have full control

over the expenditure of the funds and management of the property of the Society.

XLVI. Every Committee appointed by the Society shall at its first meeting elect a Chairman, who shall subsequently convene the Committee and bring up its report. He shall also obtain from the Treasurer such grants as may have been voted for the purposes of the Committee. Committees elect Chairman.

XLVII. All Committees and individuals to whom any work has been assigned by the Society shall present to the Council, not later than the 1st of November in each year, a report of the progress which has been made; and, in cases where grants of money for scientific purposes have been entrusted to them, a statement of the sums which have been expended, and the balance of each grant which remains unexpended. Every Committee shall cease to exist at the November meeting, unless then re-appointed. Report before November 1st.

XLVIII. Grants of pecuniary aid for scientific purposes from the funds of the Society shall expire on the 1st of March next following, unless it shall appear by a report that the recommendations on which they were granted have been acted on, or a continuation of them be ordered by the Council. Grants expire.

XLIX. In grants of money to Committees and individuals, the Society shall not pay any personal expenses which may be incurred by the Members. Personal expenses not to be paid.

L. No new law, or alteration or repeal of an existing law, shall be made except at the Annual General Meeting in March, or at a Special General Meeting summoned for the purpose, as provided in Law XIX, and in pursuance of notice given at the preceding Ordinary Meeting of the Society. Alteration of Laws.

LI. Should any circumstance arise not provided for in these Laws, the Council is empowered to act as may seem to be best for the interests of the Society. Cases not provided for.

LII. In order that the Members and Associates of the Society prosecuting particular departments of science may have opportunities of meeting and working together with fewer formal restraints than are necessary at the Ordinary Meetings of the Society, Sections may be established. Sections.

Names and Numbers of Sections.

LIII. Sections may be established for the following departments, viz :—

Section A.—Physical, Astronomical, and Mechanical Science, including Engineering.

Section B.—Chemistry, Mineralogy, and Metallurgy.

Section C.—Natural History and Geology.

Section D.—The Microscope and its applications.

Section E.—Geography and Ethnology.

Section F.—Social Science and Statistics.

Section G.—Literature and the Fine Arts, including Architecture.

Section H.—Medical Science, including Physiology and Pathology.

Meetings of Sections.

LIV. The meetings of the Sections shall be for scientific objects only.

Members of Sections.

LV. There shall be no membership of the Sections as distinguished from the membership of the Society.

Officers of Sections.

LVI. There shall be for each Section a Chairman to preside at the meetings, and Secretary to keep minutes of the proceedings, who shall jointly prepare and forward to one of the Secretaries of the Society, prior to the 1st of November in each year, a report of the Proceedings of the Section during that year, and such report shall be submitted to the Council.

Mode of appointment of Officers of Sections.

LVII. The Chairman and the Secretary of each Section shall be appointed at the first meeting of the Council after its election in March, in the first instance from Members of the Society who shall have signified to one of the Secretaries of the Society their willingness to undertake these offices, and subsequently, from such as are recommended by the Section as fit and willing.

Times of Meetings of Sections.

LVIII. The first meeting of each Section in the year shall be fixed by the Council; subsequently, the Section shall arrange its own days and hours of meeting, provided these be at fixed intervals.

Corresponding Members.

LIX. The Council shall have power to propose gentlemen not resident in Victoria, for election in the same manner as Ordinary Members, as Corresponding

Members of the Society. The Corresponding Members shall contribute to the Society papers which may be received as those of Ordinary Members, and shall in return be entitled to receive copies of the Society's publications.

LX. Associates shall have the privileges of Members in respect to the Society's publications, in joining the Sections, and at the Ordinary Meetings, with the exception, that they shall not have the power of voting; they shall also not be eligible as Officers of the Society. Privileges of Associates.

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